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Fort Belvoir, VA

NATIONAL ECONOMIC DEVELOPMENT PROCEDURES MANUAL - NATIONAL ECONOMIC DEVELOPMENT COSTS

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NATIONAL ECONOMIC DEVELOPMENT PROCEDURES MANUAL
NATIONAL ECONOMIC DEVELOPMENT COSTS

by

Charles Yoe, Ph.D.

of

The Greeley-Polhemus Group
105 South High Street
West Chester, PA 19382

for

U.S. Army Corps of Engineers
Water Resources Support Center
Institute for Water Resources
Fort Belvoir, VA 22060-5586

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Preface

This manual was prepared as part of the National Economic Development (NED) Procedures Manual Work Unit within the U.S. Army Corps of Engineers (COE) Planning Methodologies Research Program. Mr. William Hansen of the COE Water Resources Support Center (WRSC), Institute for Water Resources (IWR), manages this Work Unit under the general supervision of Mr. Michael Krouse, Chief, Technical Analysis and Research Division; Mr. Kyle Schilling, Director, IWR; and Mr. Kenneth Murdock, Director, WRSC. Mr. Robert Daniel, Chief, Economic and Social Analysis Branch (CECW-PD) and Mr. William Hunt, CECW-PD, are the Technical Monitors for Headquarters, COE.

Dr. Charles Yoe, College of Notre Dame of Maryland, was the principal author of this manual while working for The Greeley-Polhemus Group, Inc. (GPG) under contract to IWR. This manual would not be complete without an acknowledgement of the Corps personnel responsible for its preparation and the process by which they guided its formation.

From the outset, the content of this manual has been the invention of the IWR and the Field Review Group (FRG) charged with its oversight. The FRG of eleven Corps personnel was supplemented by the involvement of personnel from the Office of the Chief of Engineers and the WRSC. These personnel were interviewed along with personnel from a wide variety of Corps offices representing virtually every user of cost data throughout the agency to ascertain the range of NED and related cost issues of concern to them.

The results of the interviews were compiled to identify those issues that were of interest to a significant number of interviewees. A comprehensive list of cost-related terms used by Corps personnel was compiled. The lists of issues and terms were presented to the FRG along with a draft report outline at a July 7, 1992 meeting of the FRG. From these materials a revised and detailed draft report outline was prepared by the FRG.

The FRG group reviewed and commented on a draft report during the fall of 1992. The draft was revised to reflect the views of the FRG and submitted for another review. The revised draft and comments were the subject of a second FRG meeting held in January, 1993. This manual in its current form was approved at this meeting.

The contractor would like to acknowledge and thank, without implicating, the following members of the FRG.

Mr. William Hansen CEWRC-IWR-R
Mr. Stuart Davis CEWRC-IWR-R
Mr. William Bayert CERE-AP
Mr. Kenneth Boire CENPD-PE-EC
Mr. Glendol Combs CESWD-PL-E
Mr. Steve Cone CECW-PD

Ms. Betty Mae Eberhardt CEORD-PE-PP
Mr. William Hunt CECW-PD
Mr. Russell Iwamura CEPOD-ED-PJ
Mr. Nahor Johnson CENAD-PL-E
Mr. Larry Kilgo CELMV-PD-E
Mr. Gerald Melton CESAD-PD-E
Mr. Andrew Miller CESPD-PD-E
Mr. Richard Ring CENED-PL-I
Mr. Ronald Roberts CEMRD-EP-PE
Mr. Edmond Schiffers CEWRC-WLR-II
Mr. Gary Wickboldt CENCD-PE-PD-EC

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Chapter 1: INTRODUCTION

"Project measures, whether structural or nonstructural, require the use of various resources. NED costs are the opportunity costs of resource use. In evaluating NED costs, resource use must be broadly defined so as to fully recognize scarcity as a component of value. This requires consideration of the private and public uses that producers and consumers are currently making of available resources or are expected to make of them in the future." *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)*, p. 96, March 1983.

INTRODUCTION

Plan formulation is complete and the national economic development (NED) costs of the recommended plan are $50 million. The non-Federal partner wants to know what his share of the costs are. Cost-sharing or apportionment is based on total project costs which are $45 million. Congress authorizes the project at the cost of construction. The project cost agreement[1] (PCA) is based on the fully funded project cost, which is $60 million. The Section 902 maximum cost limitation is based on the baseline cost estimate which is established at the end of the feasibility phase and never changes, though costs may deviate from it. Is it any wonder that people become confused by the answers to a very simple question, "How much does the project cost?"

This manual provides a detailed look at NED costs. These costs are used in the plan formulation process and the economic evaluation of alternative plans. After that, NED costs are of secondary importance to implementation costs. Non-Federal partners and many elements of the Corps of Engineers may have little or no interest in NED costs. Yet, NED costs are the costs that matter most when a decision is made about recommending

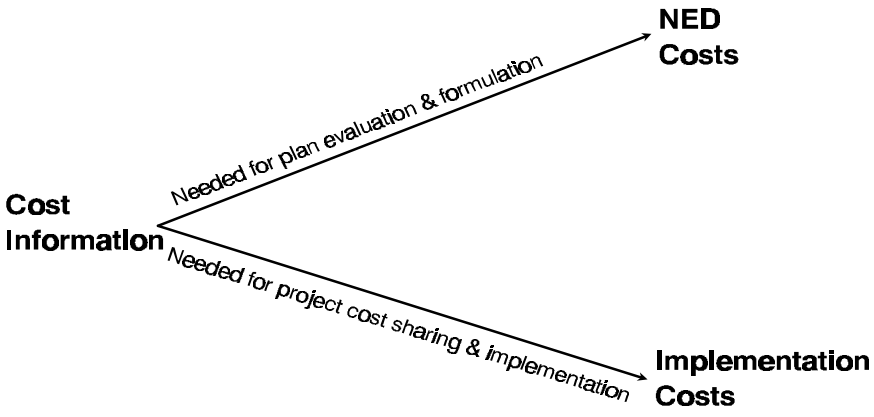


Figure 1: Dichotomous Nature of Costs

a project. This dichotomous nature of NED costs, illustrated in Figure 1, being of paramount importance in the decision process but of little interest to most parties to that process, has understandably led to a great deal of bewilderment and misunderstanding. The purpose of this manual is to replace this bewilderment with comprehension and this misunderstanding with understanding.

National economic development consistent with environmental laws and regulations is the stated policy objective of the Federal government's role in water and related land resources planning studies[2]. The NED principle articulates a very specific perspective - a national rather than state or local perspective - to be used in valuing project outputs or benefits and project inputs or costs. The NED principle is primarily an economic policy. Instances when that policy deviates from economic theory are discussed as they arise throughout this manual. It is a national water resource development policy, i.e., one that addresses what decision makers feel *ought to be* the economic priority of Federal water resource development agencies. Although it is a policy firmly rooted in economic theory, the NED principle is a matter of law, policy and interpretation.

PURPOSE

Cost, one of the most widely used words in the English language, is an extraordinarily complex concept, with all kinds of economic, financial, accounting, budget, engineering, and legal implications. As we might expect from a concept so rich in nuance, there is frequent controversy over the nature of costs. How should costs be defined? What costs are relevant for decision making? Fortunately, most of the controversy evaporates once we realize there are different kinds of problems that require different kinds of cost information.

The purpose of this manual is to provide a framework for thinking about NED costs and their various uses by the Corps of Engineers. The intent of this manual is to furnish the reader with the tools necessary to understand what NED costs are, how they are used and how they differ from other definitions of costs. To understand NED costs it is essential that the nature of these other costs be considered as well.

Costs are used by the Corps in two primary ways. First, NED costs are used to make decisions about the relative economic efficiency of alternative actions. Once such a decision has been made, dollar costs become the focus of Corps elements as they refine construction cost estimates, prepare budgets and let contracts. Non-Federal partners focus on their dollar costs as they plan for financing their share of project costs. Thus, what we will call implementation decisions require that attention be paid to a different set of costs. Though the focus of this manual is distinctly on NED costs, other costs commonly used by the Corps will be discussed as appropriate.

As important as what this manual does, is what it does not do. This manual does not define terms outside the NED context. There will be discussion and elucidation of such terms at times, but resolution of communication or other problems that arise from concepts and terminology outside that of NED costs will not be offered. There is a great deal of confusion, much of it within

the agency, about some of the cost terminology that is used by the Corps. Because the correct definition of cost varies from context-to-context, situation-to-situation and district-to-district it would be presumptuous for this manual to deign to define terms that are perfectly serviceable to those who use them. Each element of the Corps has its own program, responsibilities, context and jargon. Though it may be unfortunate that a duplicitous jargon has arisen, standardization of that jargon is a policy matter that won't be addressed by this manual.

Closely related to this last point is the fact that this is not a policy manual. There are conflicts between economic theory and principles (i.e., positive economics) and the economic policies (i.e., normative economics) of the Corps of Engineers that have developed over a period of time as a result of legislation and other policy decisions. Where appropriate these conflicts will be identified. This manual intends no advocacy position on any of these conflicts. Economic theory is the domain of the economist. Economic policy is the domain of the decision-maker.

AUDIENCE

The manual has been written for those who are partners to or have an interest in the water resources planning process of Federal water resource agencies that use the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies," more commonly referred to as the Principles and Guidelines or P&G. It provides an introduction to NED costs for non-Federal partners. Though we hope the manual serves as a useful refresher to experienced Corps planners, it is directed more specifically to new Corps employees and other experienced Corps personnel who work with planning studies.

ORGANIZATION OF THE MANUAL

The manual consists of this and five other chapters, as well as an index, two short appendices and a bibliography as shown in Figure 2. Chapter 2 discusses costs in the context of the Corps of Engineers' program. This chapter will be of most interest to readers seeking a broad overview of who in the Corps uses costs and how they use them. Chapter 3 provides an overview of some economic theory relevant to NED costs and follows with some development of the language of costs. Most of the cost terminology used by economists and Corps personnel is introduced here. Chapter 4 is devoted exclusively to a discussion of NED costs. Concepts are discussed in a format that follows the P&G

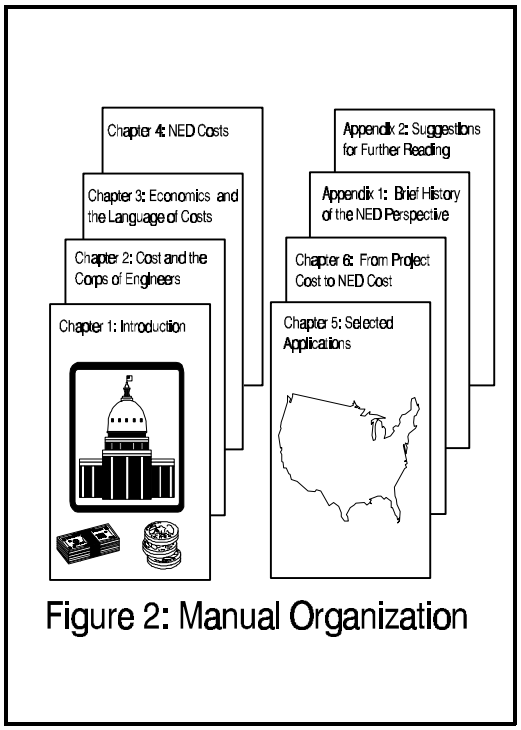


Figure 2: Manual Organization

presentation of NED costs. Selected applications of economic theory to common cost problems encountered in the planning process and clarification of the NED cost issues are presented in Chapter 5. Many of the ideas presented earlier in the manual are integrated in Chapter 6 by translating the project costs into NED project costs in a hypothetical example. An index is provided to assist readers interested in a specific topic. The first appendix presents a brief history of the evolution of planning principles for Federal water resource development agencies. The second one provides suggestions for further reading to assist those who want more details on a topic than are given here.

Chapter 2: COSTS AND THE CORPS OF ENGINEERS

CHAPTER OVERVIEW

This chapter provides a brief overview of how costs are used by the Corps of Engineers in the conduct of their missions. The emphasis is, of course, on the conduct of planning studies and the implementation of recommendations that come from them. After an overview of the role that costs play in the planning and construction functions of the Corps, attention is turned to groups that perform specific functions in the Corps program. This chapter will be most useful to those with little familiarity with the Corps' program.

ROLE OF COSTS

The Civil Works planning process begins with the perception of a problem, e.g. flooding or shoreline recession. Through a variety of means[3] the local community may request and obtain action by the Corps of Engineers. Generally, this action begins with a study of the problem and a report recommending specific responses to it. Studies, of course, take money, so study costs must be estimated, budgeted, appropriated, received, obligated and spent to accomplish the work.

In deciding whether or not to take a specific action, the Corps will consider a number of goals and objectives. The single overarching objective of the Federal government is national economic development (NED). For a plan to be implemented it must be efficient from the perspective of the nation[4]. Actions that make a positive net contribution (efficient) to the economic development of the nation may be considered for possible implementation. Actions that fail to make a net positive contribution (inefficient) to the economic development of the nation will not be taken. An economic evaluation is carried out to determine whether a particular water resource project is economically efficient or not. Only actions that are efficient from the national perspective are usually implemented.

With the problem identified, a number of alternative plans to address it are considered. As these alternatives begin to take shape, planners and engineers estimate the time and materials required to implement them. The costs of this time and these materials is estimated and becomes part of the project costs. The Federal government, in the P&G, has defined what is appropriate to consider as a cost of the alternative plans considered. This is a condition of Federal involvement in the planning process. It's also a constant source of confusion for non-Federal interests.

Once the NED costs have been identified they are expressed on an average annual basis so they can be directly compared to project benefits which are also estimated in average annual dollars. If the average annual benefits exceed the average annual costs, the project is economically feasible. The plan with the

greatest positivenet benefits that reasonably meets the planning objectives is designated the NED plan. The NED plan usually becomes the plan recommended for implementation.

If the project is efficient and acceptable, a new major issue comes to the fore - paying for the project. If the project serves more than one purpose, e.g. it reduces flooding and increases recreation, the costs of the project must be allocated to the different purposes served by the project. Then the costs allocated to each purpose are apportioned between the non-Federal partner and the Federal government based on legislated cost-sharing policies and implementing formulas.

Financial analyses are conducted to assure that the local partner has the capability to pay[5] its share(s) of project costs. The sharing and payment of costs is formalized in a project cost-sharing agreement. Up to this point, the project remains on the "drawing board" and costs are typically estimated based on the prices that prevail at that point in time. As construction becomes more imminent it is necessary to obtain better estimates of the actual amounts of money that will have to be laid out by the Federal and non-Federal entities. Because construction usually takes place over several years it's necessary to estimate what the cost of various things will be one, two, three or more years down the road. Likewise, the costs of operating, maintaining, repairing, rehabilitating and replacing the project over the next 50 or 100 years must also be estimated.

Meanwhile, other personnel are busy with the budget work necessary to get the money from Congress and the local partner at the time and in the amounts needed. Others are busy soliciting and awarding contract bids. Eventually, as the project is built and the money is spent, someone will have to keep track of all the expenditures.

Throughout this entire process, everyone is talking about costs. There are many different groups that use cost information. These costs are put to many different uses. As a result of the multitude of users and uses, problems are inevitable. Sometimes people are using different words that mean the same thing. Other times people use the same words that mean two entirely different things. Cost concepts used for efficiency decisions are frequently confused with cost concepts for implementation. The many steps to implementing a civil works project are replete with communication problems. In this chapter we briefly consider selected users of costs and the uses they make of them.

WHO USES COSTS?

Focussing on the district level of the Corps, it is possible to identify some more-or-less typical groups of users of cost information. Though districts can be uniquely organized to suit their specific needs the users identified below can be found in some shape or form in every district. The descriptions of the cost-related activities of these elements are offered as examples. They are by no means comprehensive descriptions of an element's activities.

In one district the planning function might be conducted by a planning division. In another, it may be conducted by a planning branch that is part of anengineering division. It is of no real consequence for this manual where any function is actually conducted. Hence, we refer to the group that performs the

planning function simply as Planning. The group that handles the engineering function is called Engineering, and so on.

PLANNING

Planners use cost information to make the basic efficiency decision about alternative plans. NED costs are used to make this decision. NED costs play a crucial role in the identification of the NED plan. Planners allocate costs to their various purposes and determine cost-sharing for each purpose. Preliminary estimates of project costs are prepared by planners but they typically receive information about those costs from one or more other Corps offices. Within the district, quantity estimates and unit costs are provided by engineering or, more recently, a cost engineering group. Real property values are provided by a real estate group.

Planners have the most contact with the general public and the local partners throughout the problem study and report preparation. In this role they are the first to initiate discussions about project costs. Planners frequently provide cost information to other elements of the Corps. For example, study costs may be managed by planners. Project cost estimates for the budget process are also prepared by planners.

ENGINEERING

Engineering divisions in each district typically have an organization whose function is to estimate the quantities of goods and services required to implement the alternative actions under consideration. They also provide estimated costs for the required goods and services. These estimators can often be found in a cost engineering group.

As a study progresses, the estimates of quantities and costs become more and more detailed. All cost information to this point is estimated. Actual costs are not available until contracts have been awarded and monies spent.

REAL ESTATE

Real estate personnel are responsible for estimating the value of real property, costs of acquisition and severance damages. Once an alternative plan has been identified, property acquisition is often a major cost for water resource projects. Appraisers estimate the costs of acquiring land and its improvements, relocating businesses or residences, and obtaining easements and rights of way. These costs become part of the overall project cost estimate.

PROGRAMS

Programs personnel prepare annual budget submissions to Congress and cost information for longer range planning. Cost data for budget submissions include all Federal and non-Federal costs for real estate acquisition; construction features; planning, engineering and design; construction

management; and, a contingency allowance for unforeseen changes in the cost estimate based on its level of reliability.

Project cost estimates used by programs are based on a 1 October price level for the current year with an allowance for future inflation through the construction period. Expected inflation rates reflect average annual rates over a 10-year period. Refinements of the cost estimates are coordinated with planning, engineering, construction, real estate and other personnel within the district through the project manager. Project cost estimates are updated at least annually for active projects.

PROJECT MANAGEMENT

Once the feasibility study is completed, the resulting cost estimate is used by the project management group to develop the Project Management Plan (PMP). The PMP provides details for the cost estimate and its schedule for design and construction of the entire project. Once the PMP is approved, a project cost summary is maintained by the project manager to monitor deviations from the baseline estimate. Changes to the current project cost estimates must be documented and accounted for in a formal manner through appropriate channels. Status reports submitted to headquarters are used to document and monitor district management efficiency and project performance.

OPERATIONS

Once a project has been constructed it must be operated in a manner consistent with its design to ensure that the intended project outputs are realized. Operating and maintaining a project incurs costs. Over a longer period of time, components of a project may wear out, be damaged, or become obsolete necessitating repairs or replacement. The physical deterioration that occurs over time may require a more comprehensive rehabilitation of the project. Costs of operation, maintenance, repair, replacement and rehabilitation (OMRR&R) are generally the responsibility of the operations group.

COUNSEL

Counsel's role in project costs is one of the least visible and most all encompassing. It is not unusual for Counsel to be involved in a project from the feasibility study stage through construction and even beyond. Counsel will typically be involved in real estate issues that can substantially affect costs. PCA negotiation often requires Counsel to deal directly with State and local representatives as well as agency personnel at all levels of government. Frequently, costs are the primary focus of these negotiations. Issues may range from complex and controversial discrepancies over the value of resources to the mundane but confusing establishment of construction cost accounts, such as archeological and construction accounts.

Counsel may also be required to become involved in the resolution of contract disputes that include awards and claims that can affect costs. Litigation that can result in long and costly delays or modifications of projects will naturally require involvement of counsel.

CONTRACTS

Contracts personnel are responsible for soliciting, awarding and administering the contracts required to complete studies, implement projects or to operate, maintain, repair, replace or rehabilitate projects once built. Specifications for the contract are typically provided to the contracts group by one of the other Corps offices. These specifications might describe the work to be done, for example in a planning study, or they might consist of design features and quantities required to construct a project or project component. Contract bids are solicited consistent with current contracting procedures and a contract award is made to the successful bidder.

The contract cost is generally an upper limit on costs. Contracts personnel then administer the contract to assure that payment is received for work completed. It is only after work is completed and payment is received that actual costs are known.

NON-FEDERAL PARTNER

The non-Federal partner is required to pay a portion of the costs to implement a project and often a portion or all of the normal costs of operating and maintaining it. Once a reconnaissance study has been completed local interests may be required to pay a portion (normally 50 percent) of the feasibility study costs and a portion of subsequent costs through implementation and operation of the project.

The non-Federal partner must understand the basic nature of both the NED costs and the implementation costs. NED costs are used in the determination of which, if any, alternative plans are economically efficient, i.e., feasible. NED costs are also used to determine cost allocations. Thus, NED costs are important to non-Federal interests because they are used to determine what if anything can be done to help local interests and they provide the basis for determining the local share of implementation costs [6]. Implementation costs are of obvious concern to the non-Federal partner because these are the costs they must share.

OUTSIDE REVIEWERS

On occasion where Corps reports are reviewed by personnel from outside the agency, costs are frequently a major focus. Within the Federal government, Congress, the Office of Management and Budget (OMB), and the Army Audit Agency (AAA) are a few outside reviewers extremely interested in costs. Congress is interested because they must make funding decisions; OMB because it includes or excludes projects from the President's budget; and, AAA because it conducts formal audits of selected projects. Outside the Federal government, State and local agency personnel review and scrutinize project cost estimates.

INDUSTRY PEOPLE

Corps cost estimates are often of considerable interest to industry people because of the quality of work done by the Corps. Previous estimates of project costs may provide the basis for subsequent contract bids. Often Corps cost estimates are the best source of hard to get cost data or hard to estimate costs. Conversely, costestimators for the Corps sometimes rely on industry people

for unit cost estimates. Estimated costs of dredging, for example, are most often provided by industry experts.

SUMMARY AND LOOK FORWARD

There are many users of cost information within the Corps and they make a great variety of uses of their cost information. Each of the "user groups" described here must interact with virtually every other group at some point during the study and implementation of a water resource project. For certain pairs of groups, for example planning and engineering, the coordination is constant.

Each of these groups has developed its own cost jargon. Within a group this jargon may serve the group's interests well. Outside the group communication problems can result. In the next chapter, some of the economic theory necessary for understanding the specific role of NED costs is presented. Then, much of the specific cost jargon used by the economics profession and by the Corps of Engineers are explained.

Chapter 3: THEORY AND LANGUAGE OF COSTS

CHAPTER OVERVIEW

NED costs are used for the economic analysis of alternative projects; hence, we must take an economic perspective of costs to understand the nature of NED costs. The first part of this chapter provides a brief introduction to the economic nature of costs. Most of the early material appears in sidebars because it is more technical in nature than the rest of the chapter. The sidebars can be skipped with no loss of continuity. The *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis* IWR Report 91-R-11 is a useful companion reader for this chapter and should be referred to by those looking for additional information.

The second half of the chapter offers a taxonomy of costs. The reader will find terms defined and distinctions made among terms used by economists and the Corps of Engineers in this section of the manual.

COST IN ECONOMIC THEORY

We, as individuals or collectively as a society, can't have everything we want. There simply aren't enough resources available to meet every need or want. Because we can't have everything, we must make choices. When we choose what we will do we are simultaneously making a choice about what we will not do. Thus, when we make a choice it costs us something. It costs us the opportunity to have done something else.

Economic decision making, such as the efficiency decision made during the planning process, is based on this notion of opportunity costs. The cost of any action taken is the value of the most valuable action not taken.

Non-economists think of costs as the dollars that must be expended to acquire or use something. Fortunately, in most situations opportunity costs and dollar costs are equal, avoiding the confusion that results when they are not. Unfortunately, in the case of water resources planning, there are many instances where opportunity costs and dollar costs diverge. Economists who are trying to allocate scarce resources efficiently are only interested in the opportunity costs. Those who must come up with the money to finance the project are primarily concerned with the dollar costs. The result is two groups paying attention to two different definitions of costs; two different sets of numbers. Is it confusing? Yes. Is one of the groups wrong? No, they both have legitimate but varying interests.

In this chapter basic economic concepts, fundamental to the understanding of economic costs, NED costs and the other costs frequently confronted in planning and

implementing water resource projects, are presented. The key to understanding the concepts presented here is to concentrate on the role of resources. If the use of a resource changes or an unused resource is used, there is an opportunity cost. There may or may not be a dollar cost. If the right to use a resource changes hands but there is no change in the use of the resource, there will probably be a dollar cost but there is no opportunity cost.

SCARCITY

To the person on the street scarcity implies that something is rare or difficult to find. Hen's teeth, a toaster that can accommodate a bagel, or a flattering bathing suit are a few things most of us would agree are hard to find. To an economist, scarcity means something entirely different. **Scarcity** is the term used by economists to indicate that people's desire for a "thing[7]" exceeds the amount of it that is freely available from Nature.

For example, air to breathe (not necessarily clean air), is freely available at all times and everywhere in quantities greater than desired by all the people on the earth. Thus, breathable air is currently not scarce. Try to think of another example of a good that is not scarce. It's not easy, virtually all goods are scarce. If less of a good is freely available than consumers would like; it is scarce. [8]

Scarcity does not result from the fact that a good exists in small quantities. Nor do large quantities of a good guarantee an absence of scarcity. What does matter is the relationship between people's desires for goods and their production possibilities. The only requirement for scarcity is that there be more than one use for a resource. Nowhere can this point be made as vividly as it can with water.

Consider the mythical desert oasis -palm trees and a small pond of water surrounded by thousands of square miles of barren desert. Though many would be tempted to call this water scarce, if no one or nothing desires the water beyond the modest needs of the few trees and desert insects there is no scarcity though the water resources are limited. Contrast this with the waters of the Colorado River that drain the Rocky Mountains. Watching the raging torrents of this river in the isolated wild through which it sometimes winds, it is difficult to imagine ever running out of water in this river. Yet, we know all too well that desires for the waters of the Colorado exceed that river's ability to satisfy society's thirsts for its flows.

CHOICE AND OPPORTUNITY COST

Scarcity of any resource dictates that choices be made. Choosing more of one thing simultaneously means choosing less of something else. Choose to preserve the spotted owl and you are simultaneously choosing not to harvest the trees in which they live. When we have the opportunity to do more than one thing with a resource, for example, to use land as wildlife habitat or to store water on it for municipal usage, every choice costs us an opportunity to have done something else.

Frequently, that which a choice costs us cannot be quantified in dollar terms. Suppose you are at a carnival where a new ride is being promoted by letting everyone ride free. As you take your place in line you notice the sign that says, "one hour wait from this point." Is the ride free? With the hectic lives most of us lead leisure time is very precious to us and the opportunity cost

Opportunity Cost Illustrated

Consider a simple society that has a finite amount of water resources and a fixed and given level of technology. Assume that water can be put to instream uses such as hydropower, recreation and environmental quality, or it can be withdrawn and put to agricultural, municipal and industrial uses. The production possibilities frontier in the figure shows all the possible combinations of instream and withdrawal uses that can be made if all the water is used fully and efficiently, given the existing technology.

The frontier itself divides society's choices into two groups of combinations of instream and withdrawal uses: the attainable which includes the area inside the curve and curve itself; and the unattainable, the area outside the curve which can't be realized with current resources and technology. In a world beset with scarcity there are always limitations on society's ability to get all they want. The combination of instream and withdrawal uses indicated by point A is not possible given current resources and technology.

People are forced to make choices from among the attainable options. If all resources are devoted to instream uses, then a maximum output of instream uses, shown as the distance OB, will result, with no withdrawal uses. If, on the other hand, all resources are devoted to withdrawal uses, a maximum of OC withdrawal goods could be produced. Society's **production possibilities frontier** restricts peoples ability to have all they want. It is worth noting that points inside the frontier are attainable but inefficient. For example, the combination of point G can be produced but society has no reason to do that. They can produce more of both withdrawal and instream goods by moving to point D. It would be wasteful to produce at G.

Using the production possibilities curve, it's easy to see how choice comes with costs. If society chooses OB of instream uses they must forego OC of withdrawal uses. The benefits are OB, the costs OC. The choice is, however, not an all-or-nothing choice. Society may prefer a combination of both goods such as shown at point D. OE of instream uses means society must forego the opportunity to produce an additional FC of withdrawal goods. Likewise, the production of OF withdrawal uses means society will lose the opportunity to produce an additional EB of instream goods.

It makes sense to move from all instream uses to a point like D if the value of OF, the withdrawal uses gained, exceeds the value of EB instream uses foregone. Benefit-cost analysis is conceptually nothing more than the systematic valuation of such trade-offs, albeit in more complex situations.

of waiting in line may be very high indeed, though it is not a cost that can be easily quantified in dollars.

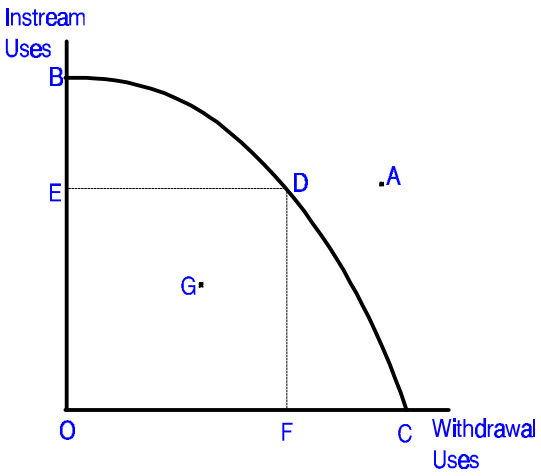
A more pertinent example occurs when we choose to rehabilitate a lock that will produce impacts like noise. The noise from construction may disrupt the migration of waterfowl to a nearby wildlife preserve. The shorter lockage times that result from rehabilitation costs us, among other things, the opportunity to have undisturbed migration of waterfowl. Project costs of concrete and steel are much easier to quantify in dollar terms than is the disruption of waterfowl migration.

Economists view costs differently than most people do. To an economist cost is not necessarily the amount of money you have to spend to produce or buy something. The real measure of cost is opportunity cost, i.e., the value of that which is foregone when a choice is made. The more you valued the alternative opportunities, the higher is your opportunity cost.

Society, like individuals, faces scarcity and must make choices. Society incurs opportunity costs as well. Consider the production of a new lock and dam that uses land, labor, materials, and equipment worth roughly $600 million. That same quantity of resources could have been used to build 100 miles of electrified railroad, one nuclear attack submarine or thousands of other things. To make this more personal let's consider what the money costs could mean to us. Assume the $600 million was raised through taxes. If taxpayers had kept their money they would have spent it on clothing, entertainment, automobiles, etc. Hence, we could see the opportunity cost of the lock and dam as the consumer goods that would have been enjoyed had the project not been built.

EFFICIENCY

The purpose of economic analysis of water resource projects is to aid the efficient allocation of the Nation's scarce natural resources. We don't want to waste resources. We don't want to pay more than we have to for a project and we don't want to pay more than it is worth. This is easier said than done.



Production Possibilities Frontier

The goal of economics is the **efficient** use of resources. **Economic efficiency**, for society as a whole, is achieved when we produce the combination of outputs with the highest attainable value given our resources. Economic efficiency at the national level is the intent of the **National Economic Development (NED)** objective. A water resources project should be economically efficient. Anything else would be wasteful. If we use our natural resources to produce a combination of project outputs that is less valuable than another feasible combination of project outputs, we could have done better.

A TAXONOMY OF COSTS

The simple notions of scarcity, choice and opportunity cost underlie the economist's concept of costs but the economist's ideas about costs are very different from other's views of costs. As most people are not trained in economics they often find opportunity cost less compelling than a price tag. Nonetheless, it is the economist's view that is most relevant when considering

Because costs are the focus of this manual it is useful to consider from where costs come. Costs result from ordinary production activities. A production process takes inputs and combines them via some technology to produce outputs. Planning and implementing water resource projects is, in this sense, very much a production process.

the many different disciplines required to develop and implement a plan.

Outputs require inputs and technology. The cost of producing that output is based on the prices of each input and the quantities of each input. The quantity required is determined by the technology.

Production Function

Inputs for a water resources project are resources that include many types of labor, materials (e.g., concrete, steel, rip-rap), equipment (e.g., drills, earth-moving machinery, cranes, handtools), and land. The outputs of a project are flood control, hydroelectricity, transportation services, recreation, water supply, etc. The technology used to combine these inputs and turn them into the desired outputs resides in the knowledge and techniques imbedded in

Consider a sample production example where the only input is levees, measured in levee section (LS) and the output is flood control, measured in the number of structures protected (SP), as shown in the table. Column one shows the number of LS of levee; column two shows the incremental (marginal) product of each LS; column three is the cumulative number of structures protected; column four shows the incremental (marginal) cost of each structure protected measured in LS rather than dollars.

MARGINAL PRODUCT & MARGINAL COST

Sections of Levee	Incremental Structures Protected	Total Structures Protected	Sections of Levee Per Structure Protected
0	0	0	--
1	20	20	0.050
2	24	44	0.042
3	15	59	0.067
4	11	70	0.091
5	7	77	0.143
6	3	80	0.333
7	0	80	infinity

(Continued next page)

Production, Resources and Costs (Continued)

The first LS protects 20 structures at a cost of 0.05 LS per structure protected. The second LS protects 24 additional structures for a total of 44 structures protected by the two sections of levee. The additional 24 structures cost 0.042 LS each. The seventh LS protects no additional structures so the incremental cost goes off to infinity. Additional sections of levee would require the removal of structures so the incremental protection actually becomes negative. These are not shown.

Column four shows the amount of resources required to produce each additional LS. Production has costs. Those costs are measured here in terms of the resources required to produce an output. If a LS costs $1 this is equivalent to multiplying the values in columns one and four by $1 so they can be reinterpreted as the dollar costs of protecting structures. It is usually a simple step from resource costs as shown in column four to dollar costs as long as the cost of the resource has a known price.

The purpose of this example is to clearly establish the link between resources and dollar costs. From an economic perspective, the true costs are the value of resources used. If the resources used have a price, as most resources used in a water resources project do, project costs can be expressed in money terms.

Looking ahead to the problems that arise when resource and money costs diverge from one another two points need to be made here. First, true economic costs are expressed in terms of resources used. If there is no change in the resources used there is no cost. Second, if the resources used have no readily discernible price it will not be easy to express costs in dollar terms.

national efficiency and it is the economist's view that is the basis for NED costs.

In the following paragraphs we offer a taxonomy of some of the cost terminology most commonly used by economists and the Corps of Engineers. The language of costs is extraordinarily complex. The jargon has economic, accounting, engineering, financial and legal implications. There are frequent controversies and misunderstandings about the nature of costs. What words should be used? How are they defined? Which terms are relevant? The particular information required varies from one problem to another.

Within the Corps' program, costs can be classified into two major categories of particular interest in this manual and a third category of less interest here. Figure 3 shows these categories. First, cost information is required to formulate water resource projects. It is specifically needed to answer questions of economic efficiency posed during the planning process and to select a recommended plan. Second, cost information is required to implement water resource plans. Someone must pay for the project. Third, the Corps' budget requires
extensive cost information to run the Corps' program.

Economics, as a discipline, and the Corps, as an agency, both operate within the functional areas of Figure 3. Though both speak the common "language" of costs each has its "dialect". With economists and agency people working together on formulation and implementation issues the potential for communication problems is widespread.

The economist's "dialect" is predominant among the formulation

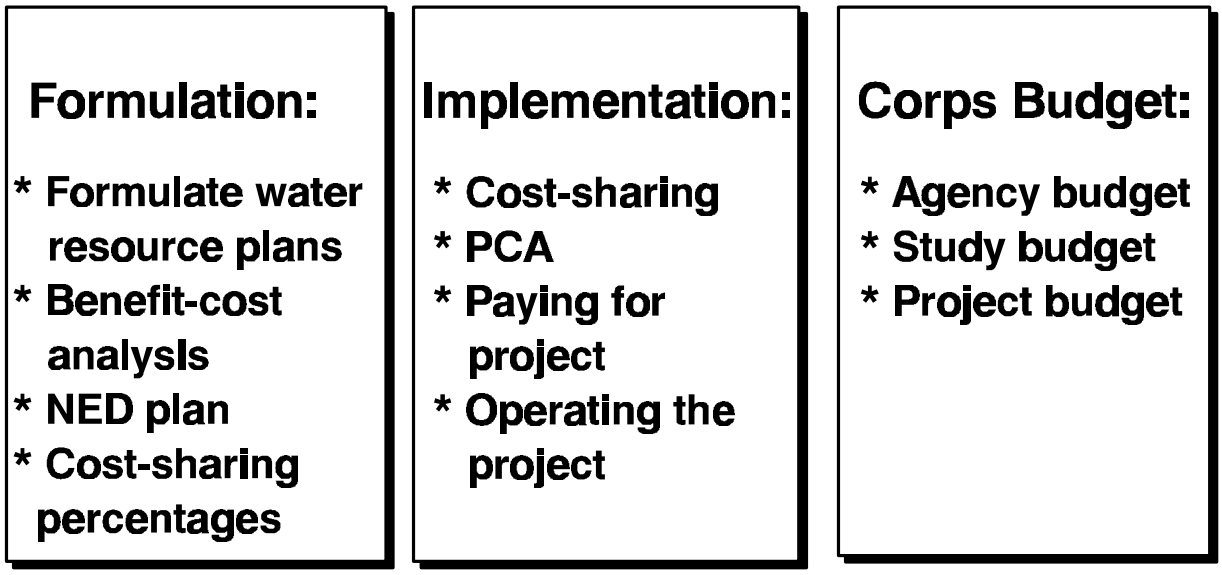


Figure 3: Major Uses of Costs

functions. The economist's jargon is built upon the basic concepts presented earlier in this chapter and is addressed first in the remainder of this chapter. The Corps' "dialect" is preeminent in use for the implementation functions and is addressed next. This terminology is principally the innovation of the Corps of Engineers. The third category of costs is not explicitly addressed in this manual.

THE LANGUAGE OF ECONOMISTS

Figure 4 maps the topics of this section. Beginning with the concept of opportunity cost we work backwards, decomposing them first into explicit and implicit costs. Each of these can, in turn, be comprised of internal and external costs. Figure 4 shows the relationship of these costs. Once these basic concepts are defined the differences between economic and money costs are discussed.

The remainder of this section turns to the cost terminology that is most familiar to non-economists. Marginal costs are the relevant opportunity costs for most water resource decision problems. Incremental costs are a special type of marginal cost. The typical cost

Opportunity Cost

- Explicit & Implicit Costs
- Internal & External Costs
- Economic & Money Costs
- Marginal & Incremental Costs
- Fixed & Variable Costs
- Average Costs

FIGURE 4: OPPORTUNITY COST COMPONENTS

relationships that follow are the costs that comprise a major portion of the cost theory presented in microeconomic theory courses. The section concludes by considering two topics that greatly influence economic notions of cost: time and price level.

Economic cost, **opportunity cost, resource cost** and **NED cost** are some of the phrases frequently used by economists that remain a mystery to most people. They are all very close in meaning but they vary by context and nuance. The key to understanding opportunity cost is, as mentioned above, to understand that every time we make a choice it costs us something. Fortunately, the price of a good or service is usually a proper measure of opportunity cost. It is, however, significant that the definition of opportunity costs does not refer to or depend on dollars. Any choice incurs a cost. Donated land or land already owned by the project sponsor has no dollar cost. When we choose to use it for a project, a cost is incurred because we forego the opportunity to use the land in some other fashion at some future point. Whether that cost is ever covered by an actual expenditure of money or not is immaterial to the existence of a cost.

Economic cost means exactly the same thing as opportunity cost. Economic cost more directly conveys the notion that these are the costs of concern to economists. Resource cost is, as previously noted, the basis for opportunity cost. Resource cost is generally used to shift the focus of cost considerations back to the real resources that are being used and away from the exchange of money.

NED cost are defined as "the opportunity cost of resource use." For the most part, NED cost means exactly the same thing as opportunity or economic cost. Policy decisions over the years have caused the concepts of opportunity cost and NED cost to diverge in some few cases. For example, the opportunity costs of providing better housing for people relocated as a result of a project are, by policy, excluded from NED costs. Thus, we cannot say that NED cost and opportunity cost are identical, though that appears to have been the original intent.

Economic Cost

a. Explicit Cost versus Implicit Cost. Opportunity costs are the sum of explicit plus implicit costs. The costs of using resources in producing outputs involve out-of-pocket costs and noncash costs. **Explicit costs**, sometimes called **money costs**, are out-of-pocket expenditures for goods and services received. When you have to write a check or turn over cash to complete a transaction you have incurred an explicit or money cost. These costs are relatively easy to identify. However, it should be noted that not all explicit costs are opportunity costs. This topic is taken up in the following section on economic and money costs and again in Chapter 5.

Another kind of opportunity cost is **implicit cost** sometimes called **imputed cost**. Implicit cost is a noncash[9] cost that does not show up in accounting records. Implicit costs are nonetheless opportunity costs and are important for decision-making.

Suppose you own an office building downtown that could be rented for $10,000 per month. If you use this building to house your own business you incur costs. You

Resource Costs

Resource costs are mentioned in the P&G but the term "resource cost" is not often encountered in the economics literature. Opportunity costs represent the use of resources and they are often expressed in dollar terms. Resource costs, on the other hand, are always expressed in quantities of resources used. The concept of resource costs can be an extremely useful one in clarifying some of the discrepancies between what is an NED cost and what is an implementation cost.

For example, consider a cubic yard of concrete used in a project. What does the rest of the economy/society ultimately lose when this concrete is used for the project? Picking up on the concept of opportunity cost developed above, society loses the alternative uses for this concrete. It may have been used for a few blocks of sidewalk, a driveway, or in the construction of an office building. It's use in a project precludes its use in any of these other endeavors. The resource cost is one yard of concrete but its money cost represents the value of that concrete in its next best alternative usage. The dollar cost per cubic yard of concrete is a reasonable estimate of the opportunity cost of the concrete. The resource cost includes the labor, raw materials and equipment required to produce and transport the concrete.

Now let's consider an acre of government-owned wetlands used in a project. Because the wetland is already owned by the government there will be no dollar cost to acquire it. Clearly there is a resource cost. To determine the true economic cost of the wetland we again ask the question, "What does the rest of the economy/society ultimately lose when this wetland is used for the project?" Wetlands provide habitat, they can be important links in the food web and energy chain, they may provide recreational opportunities or scenic values. All of these uses are lost. Can we place a dollar value on the highest of these foregone opportunities? Perhaps, but not very easily or reliably. Nonetheless, the use of the wetland costs society something. The resource cost is easy to identify, one acre of wetlands. If the project cost estimate is to reflect the true economic costs we must estimate a dollar value for the resource cost, though no one will ever have to actually pay this cost. The dollar value of the resource cost is an NED cost.

Suppose an unemployed person is used to build a project. What does the rest of the economy/society ultimately lose when this person is used for the project? If he had no job and was producing no output, society will lose little. Thus, society will sacrifice very little to use him for this project. The opportunity cost of this person's time is very low, though it is not zero. The economic cost of his labor is considerably less than the money wage he is paid.

Economic theory would suggest that the opportunity cost of his time be based on the value of the lost opportunity, presumably foregone leisure, rather than the wage paid the worker. This would result in economic costs below the money costs of the project. Corps' policy has determined that rather than use this approach some of the money wages paid can be considered redevelopment benefits if the project area meets certain qualifying criteria. The effect on net benefits will be the same whether NED costs are reduced by a certain amount or NED benefits are increased by the same amount.

Let's consider one final example. Suppose we have a streambed that will continue to be used as a streambed in a project. What does the rest of the economy/society ultimately lose when this streambed is used for the project? In this case, society loses nothing at all. The land that constitutes the streambed was originally a submerged streambed and its use does not change at all. There is no opportunity cost of this resource because there is absolutely no change in the way the resource is being used. Society will lose nothing. Will there be a dollar cost for this resource? Perhaps. Someone owns the streambed in question. If they are asked to relinquish their

(Continued Next Page)

Resource Costs (Continued)

ownership, they are transferring the right to use a resource, which is quite different from the actual use of the resource, to someone else. The sale of that right may be judged to have a monetary value, despite the fact that there is no true economic cost.

The question posed in each of these examples, "What does the rest of the economy/society ultimately lose when this resource is used for the project?," is critical for translating the idea of resource costs to opportunity costs. The next question is "Can the opportunity cost be readily quantified in monetary terms?" When the resource used has an opportunity cost that is easily quantified in monetary terms there are few problems. When this is not true, however, cost estimating can become complex and confusing.

have the explicit costs of labor and materials, etc. to pay each month. In addition you have the implicit cost of using your building, a scarce resource. If you did not use your building you could earn $10,000 in rent each month. Though you may not owe a penny on this building it costs you $10,000 a month to use it. You have the opportunity to make $10,000; foregoing that opportunity costs you that $10,000.

Whether you make an explicit payment each month or bear an implicit cost, the cost to you in either case is identically the same. You may have a different psychological reaction to an explicit cost than you do to an implicit cost, but the cost is the same. For example, losing recreation activity valued at $1 million per year (an implicit cost) is as much an opportunity cost as buying $1 million worth of concrete.

b. Internal and External Costs. Implicit costs may be internal or external. Likewise, explicit costs can be internal or external. **Internal costs**, sometimes called **private costs**, are the costs borne directly by the person, firm or entity that is taking some economic action, i.e., consuming or producing something. The internal costs of consuming a cup of french fries at the beach is the time spent waiting in line for them, the price of the fries, and the health effects of consuming fried food. These are all internal costs. Some of these costs are explicit, the price of the fries; and some of them are implicit, time in line and health effects.

External costs are the costs of an activity that are borne by parties not directly involved in the activity. When you get in line for fries you increase the time that anyone arriving after you must wait in line. If it takes 2 minutes to serve you and there are 20 people in line behind you, your presence costs the group 40 minutes of time. Thus, your presence on line imposes costs on others. If you carelessly toss your cup on the ground after consuming the fries you impose a cost on others as well. Someone will expend some resources to pick-up your cup.

If you are a typical consumer you will consider only the private costs of your actions in deciding whether to undertake an economic activity or not. A ten minute wait and a $3 cost are important to you. That you may cause others to wait a cumulative 40 minutes and cause an expenditure of &1 to have your litter picked up are of no concern tp you.

Another Meaning for Incremental Cost

Among Corps' planners "increment" does not mean the same thing it means to economists. To the Corps planner, an increment is a part of plan and the costs of that part of the plan are often referred to as incremental costs. Incremental cost in this context does not mean the same as it does in the preceding discussion.

An increment is a term that takes its meaning from its context. Planners may speak of an increment of protection as a part of a plan. In this case, increment means an increase in output as described above. In other cases, increment is used to describe a part of a plan that is more accurately a **separable element** of the plan. For example, a water resources plan might consist of one or more separable elements or components that are hydrologically independent of one another. The working definition of "hydrologically independent" is that such a component of a plan could be built and would function by itself. It does not require another component to assure its proper functioning. Such plan components are often called increments.

Levees protecting development on the right and left banks of a river can be considered separable elements. Their proper functioning is independent of one another. Unfortunately, for the purity of the language, these levees are often called plan increments. Within one of these separable elements we can have vertical (level of protection) and horizontal (area protected) increments of protection. Once planners use increment indiscriminately to refer to any or all of these components of the plan "incremental cost" becomes a very difficult term to understand. Used in this way, it no longer bears a resemblance to incremental cost used in marginal analysis. The only solution to this confusion is to beware of the context in which the term is used.

Social costs are sometimes defined to be the sum of all internal and external costs. In this interpretation they are essentially opportunity costs. Less frequently social costs may be used synonymously with external costs. In this sense they are costs imposed on the rest of society by the actions of an individual or some other agent of economic activity.

Pollution is the classic example of an external cost. A papermill incurs costs to produce the paper and dumps its untreated wastes into an adjoining stream. The costs directly borne by the papermill include raw materials, labor, rent, interest, etc. Clean water is another resource used up in the production process as wastes are dumped in the river. Because the costs of pollution are borne by the fishermen on this river and the downstream town that must remove the wastes before drinking the water, not all costs are borne by the mill. The external costs are imposed on third parties.

External costs are commonly encountered in many of the Corps' missions. For example, a permit was requested to open a boat salvage yard along a major river. Adjacent to the proposed salvage site was a popular urban park. An estimate of the costs of the salvage operation was very thorough in estimating the costs of building, owning and operating a salvage yard. They did not include the external costs. In this case, considerable cost was imposed on the park as the quality of the recreational experience was significantly diminished by the noise, odors, and sights introduced by the yard. The nature of the park was changed by the

introduction of the salvage yard. In retrospect, it is not apparent that had the analysis thoroughly investigated all the relevant costs of the yard, including external costs imposed on the park, that the permit would have been given because the operation may in fact be economically inefficient.

c. Economic and Money Costs. Many Corps planners are familiar with the terms **economic cost** and **financial cost**. The working definitions go something like this: economic costs are those costs economists use to calculate the benefit-cost ratio; financial costs [10] are the costs that someone is going to have to pay. In recent years a financial analysis has become a standard part of every Corps project. To avoid confusing people by using the term "financial cost" when it does not refer to this financial analysis we will use the term **money costs** in this manual.

In the context of this manual **economic cost** has two meanings. First and foremost economic costs means opportunity costs. Second, in the context of the Corps mission, economic costs has come to mean the costs that are needed for the economic analysis or NED costs. Though there may be different nuances to the two definitions[11] they can effectively be considered synonyms.

Opportunity costs can be considered to consist of two parts, explicit and implicit costs. If economic costs are identical to opportunity costs then one would conclude that economic costs are equal to implicit plus explicit costs. There is a little recognized problem with making this connection, however. There can be an explicit cost without there being any opportunity cost.

The streambed example from above comes to mind. A streambed is a resource. If a streambed has always served as a streambed and always will, there are effectively no alternative uses for the resource. If there is only one use for a resource and it is already being put to that use then it does not cost society anything to continue to use it in this fashion. There is no next best alternative use to which the resource can be put, so there is no opportunity cost.

In the U.S., ownership of a resource conveys certain rights of usage or **property rights**. Property rights are a legal construct and we distinguish the right to use a resource from the use of the resource. It is the use of the resource that incurs the opportunity cost for society. The right to use the resource does not impose an opportunity cost. The exchange of property rights is an exchange of something of value that has no effect on a resource's use, it merely transfers the right of usage from one person to another.

If a project requires that the right to use a resource be acquired there will be an out-of-pocket cost. Someone will make an explicit payment for the right. These cases where explicit costs do not entail opportunity costs are rare. Though there is a temptation to ignore them for the sake of simplicity we cannot. Unfortunately, the exceptions to the rule are the most confusing cases. The best we can do here is to point out that economic or opportunity costs can almost always be defined as explicit costs plus implicit costs. There are, however, circumstances where that is not true. In the greater scheme of

water resources planning this distinction in terminology is minor, but it is a distinction of which planners and economists must be aware.

Money costs are explicit costs. They are the costs that must ultimately be paid in dollars. Money costs are relevant for the financing decisions that Congress and the non-Federal partner must consider when deciding to support a project or not. As noted in the preceding paragraphs, not all money costs are economic costs.

It is tempting to say that the difference between economic and money costs is implicit costs. That is almost but not quite true. The difference between
economic and money costs is that economic costs include all implicit costs and omit explicit costs that do not impose an opportunity cost on society.

d. Marginal and Incremental Cost. Few notions of cost are more important to economists and less understood by non-economists than **marginal cost** and **incremental cost**. Water resource projects produce outputs. Marginal and incremental costs are dependent upon the amount of output produced by a project. Marginal cost is defined as the *change* in total cost divided by the *change* in output. In other words, it is the amount by which costs change when output is increased or decreased. Incremental costs are defined the same way. The difference between the two terms is that the change in output is arbitrarily small for marginal cost and a larger more discrete change for incremental cost. Thus, marginal cost would be appropriate when hydropower output increases by a kilowatt. Incremental cost would be appropriate when output increases by 200,000 kilowatts. Incremental cost is the term used most often by the Corps of Engineers [12].

In water resources planning incremental costs are encountered more often than truly marginal costs. Hydropower capacity changes are given in thousands of kilowatts rather than kilowatts. Levees raising are considered several feet at a time not inches. For the purposes of this manual, however, there are no substantive differences in the interpretation of the two terms and they will be used interchangeably. This would not be an appropriate use of the terms in a more rigorous economic context.

The significance of incremental or marginal costs lies in its role in marginal analysis. Marginal analysis is used to identify the optimal or best action. This is usually done by making something as large as possible (e.g., net benefits) or as small as possible (e.g., costs) subject to certain constraints. In the case of water resources planning the economic analysis seeks the plan that maximizes net NED benefits. From an economic perspective this is the best plan.

The best plan is found by applying marginal analysis, which is briefly summarized by the decision rules shown in Figure 5[13]. The rules, expressed in terms of marginal values, could be just as easily expressed in terms of incremental values. From some starting point, usually the without project condition, we begin to consider the incremental benefits and incremental costs of varying levels of project outputs (i.e., differing levels of protection, depths of channel, acre-feet of water).

An example of incremental analysis is shown in Table 1 using outputs as they

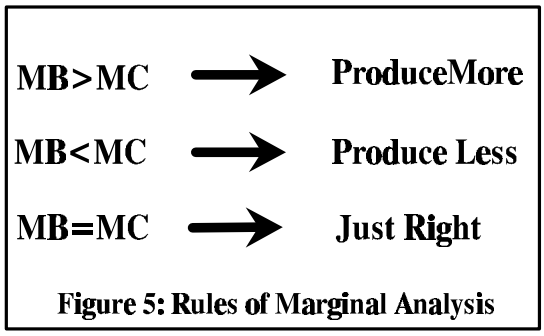


Figure 5: Rules of Marginal Analysis

are more likely to be defined in a Corps study. Total costs are evident in column three and the change in these costs is easy to see. The output of this project appears to be the level of protection. An economist might look at this table and consider output to be measured in years of protection. Seen this way, the incremental cost of going from 10-year protection to 50-year protection is \$60/40 or \$1.5 per year of protection.

It is not reasonable to define feasible increments of flood protection one year apart. The feasible flood control projects are defined as the levels of protection shown. Output, for purposes of defining increments of output from alternative plans, is, in essence, a cardinal ranking of the projects from lowest to highest cost. The change in costs and benefits are always calculated directly from the corresponding totals and the change in output is very often arbitrarily assigned the value one. Hence, the change in output is obtained from the ranking in the first column.

Planners must often identify a range of project outputs to investigate before any data are available. Because of the substantial time and money required to investigate these alternatives the incremental analysis must often be based on these alternatives as a practical matter. Whenever possible the incremental analysis should be as true to the economic ideal of marginal analysis as possible.

Proceeding with the example of Table 1, 10-year protection is valued at \$120 and costs only \$50 so it should be produced. We look at the next level of output, 50-year protection. The value of the single unit (per change in column 1 size ranking) increment of protection between 10-year and 50-year is valued at \$100. The cost of providing this increment of protection is \$60. It is worth producing. Following this logic we continue

TABLE 1: INCREMENTAL ANALYSIS

Level of Protection	Total Benefits	Total Costs	Increment Benefits	Increment Costs	Efficient Increment
10 years	120	50	120	50	Yes
50 years	220	110	100	60	Yes
100 years	305	180	85	70	Yes
200 years	380	255	75	75	Yes
500 years	440	335	60	80	No

to produce protection. At 200-year protection we see it costs $75 to produce an increment of protection that is valued at $75. This is where net benefits are maximized. To be sure check the next increment of protection from 200 to 500. The benefits are $60 while the costs of providing it are $80. It would be a waste of resources to use something valued at $80 to produce something valued at $60. Thus, we would not produce this level of protection and would move back to the previous level of output, 200-year protection. The *National Economic Development Procedures Manual-Overview Manual for Conducting National Economic Development Analysis* provides a more thorough discussion of marginal analysis.

In summary, as long as the marginal benefits exceed the marginal costs then production should be increased. When it does, the value society places on the increased output exceeds society's cost of producing it. Whenever we can produce something that is more valuable than the resources used to produce it, we should do so. When incremental costs exceed incremental benefits we have overproduction. Society is producing something that is not worth the cost of producing it. This situation can be remedied by producing less.

The economically efficient level of output is that at which incremental benefits equal incremental costs. At this level society places an equal value on the resources used and the output produced. If more were produced society would be experiencing a net loss of welfare. If less were produced, society would be foregoing a net gain. Both overproduction and underproduction are inefficient from society's perspective.

e. Typical Cost Relationships. The material that follows presents the basic cost relationships of microeconomic theory. Though basic to economics, these cost relationships are not often used explicitly in the planning process and will be of limited interest to non-economists. Figure 6 summarizes the typical cost relationships that are derived from the production processes that underlie the costs incurred from the act

Fixed Cost + Variable Cost = Total Cost

$$\frac{\text{Fixed Cost}}{\text{Quantity}} + \frac{\text{Variable Cost}}{\text{Quantity}} = \frac{\text{Total Cost}}{\text{Quantity}}$$

Average FC + Average VC = Average TC

$$\frac{\Delta FC}{\Delta Q}^{0} + \frac{\Delta VC}{\Delta Q} = \frac{\Delta TC}{\Delta Q}$$

Marginal Variable Cost = Marginal Cost

Figure 6: Typical Cost Relationships

of producing an output. **Total costs** are all opportunity costs. Some of these costs change as the output changes and some do not. We can concentrate on only the changes in costs, i.e., the marginal/ incremental costs discussed above, or we can look at the sum or average of costs.

1. Fixed Cost versus Variable Cost. Economists frequently divide costs into the two broad categories of fixed and variable costs based on the response of costs to changes in output or production. **Fixed costs** do not vary directly with the level of output. Suppose you rent a small garage for a car repair business you run. The monthly rent is $500. You produce car repairs. If you repair 500 cars per month your rent is $500. If you do not repair a single car your rent is $500. Your rent is a fixed cost. It is not a function of your output.

No costs are fixed forever. In the long-run, all costs are variable. To talk sensibly about fixed costs we need to keep a certain time frame in mind; that time frame is called the short-run. In the short-run some factors of production are fixed. For example, in the short-run the size of a reservoir is fixed for a reallocation study. We are limited to the size of the existing structure for some period of time. In the long-run no factors of production are fixed. Given enough time we can increase or decrease the size of the reservoir. Thus, costs are not fixed in the sense that they never change; they do not change in the short-run and they do not change because of changes in the level of output.

Overhead is a term that some consider synonymous with fixed costs. If overhead includes only rent, franchise fees, interest on loans, depreciation of equipment unrelated to usage and other costs that do not vary with output, the terms are identical. In reality, overhead usually includes some costs that are fixed and some that are variable, such as utilities, so the terms are not usually identical.

Variable costs are those costs that vary with the level of output. Because only variable costs change when output changes, marginal variable costs are the same as marginal costs (See Figure 6). The variable costs of operating your garage include labor, electricity, oil and fluids, rags, tools, supplies, etc. Variable costs may remain fixed over certain ranges of output. For example, labor may cost $10 per hour for every hour worked. Because the number of hours worked varies with the level of output, labor costs are a variable cost.

2. Average Costs. Average costs or average total costs are obtained by dividing total costs by the quantity of output. Commonly used average costs are defined below:

(1) Average Total Costs = Total Costs/Quantity

(2) Average Fixed Costs = Total Fixed Costs/Quantity

(3) Average Variable Costs = Total Variable Costs/Quantity

3. Cost Curves. Figure 7 shows the theoretical shapes and relationships of the typical cost curves to one another. Table 2 shows typical cost data. A complete development of these relationships is beyond the scope of this manual, however, some basic observations follow:

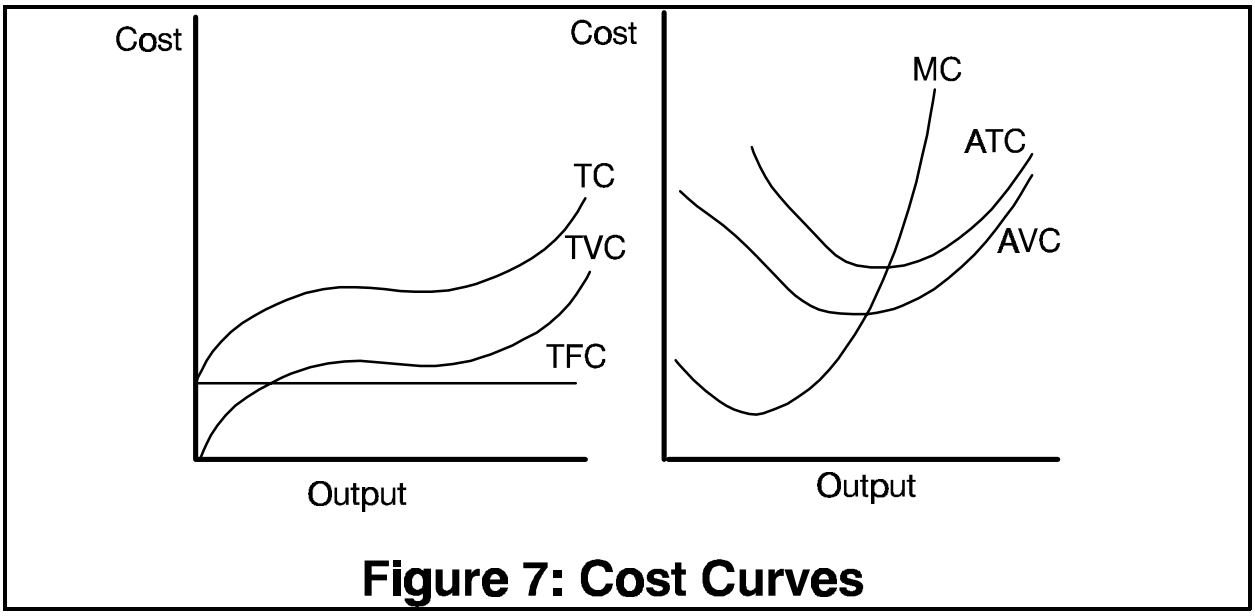


Figure 7: Cost Curves

1) Variable costs and total costs increase with the quantity of output produced.

2) Fixed costs do not change.

3) Marginal costs [14] typically decline at first then rise consistently over all additional increases in output. [15]

4) Average fixed costs get smaller and smaller as output increases but they will always remain positive.

5) Average variable costs always lie below average total costs.

6) Average variable and average total costs have a U-shape. They decline, reach some minimum and then begin to rise.

7) Marginal costs equal average variable and average total costs when the average costs are at a minimum[16].

f. Long-Run/Short-Run Cost Considerations. In economics, the long-run and the short-run are periods of time of indefinite and variable length. The **short-run** is defined as that period of time during which at least one input in the production process cannot be varied in quantity. For example, reallocation of an existing reservoir's water supplies are all short-run decisions because the size of the reservoir is fixed and cannot be varied.

In the **long-run** all inputs are variable, i.e., none of them are fixed in quantity. In the long-run a reservoir's size can be altered making possible allocations that are currently infeasible. During the planning process, before a reservoir is built, it can be many different sizes. Once it is built and the size becomes fixed, all subsequent operation/ reallocation decisions are short-run decisions. Most planning work involves making long-run decisions. Changes in operation and reallocation decisions involve short-run decisions.

TABLE 2: TYPICAL COST DATA						
Quantity	**Fixed Cost**	**Total Cost**	**Average FC**	**Average VC**	**Average TC**	**Marginal Cost**
1	$50.00	$ 55.00	$50.00	$ 5.00	$55.00	
2	$50.00	$ 58.00	$25.00	$ 4.00	$29.00	$ 3.00
3	$50.00	$ 60.50	$16.67	$ 3.50	$20.17	$ 2.50
4	$50.00	$ 63.00	$12.50	$ 3.25	$15.75	$ 2.50
5	$50.00	$ 65.00	$10.00	$ 3.00	$13.00	$ 2.00
6	$50.00	$ 68.00	$ 8.33	$ 3.00	$11.33	$ 3.00
7	$50.00	$ 72.75	$ 7.14	$ 3.25	$10.39	$ 4.75
8	$50.00	$ 78.00	$ 6.25	$ 3.50	$ 9.75	$ 5.25
9	$50.00	$ 86.00	$ 5.56	$ 4.00	$ 9.56	$ 8.00
10	$50.00	$ 95.00	$ 5.00	$ 4.50	$ 9.50	$ 9.00
11	$50.00	$104.50	$ 4.55	$ 4.95	$ 9.50	$ 9.50
12	$50.00	$115.20	$ 4.17	$ 5.43	$ 9.60	$ 10.70
13	$50.00	$130.00	$ 3.85	$ 6.15	$10.00	$ 14.80
14	$50.00	$149.10	$ 3.57	$ 7.08	$10.65	$ 19.10
15	$50.00	$174.75	$ 3.33	$ 8.32	$11.65	$ 25.65
16	$50.00	$212.00	$ 3.13	$10.13	$13.25	$ 37.25
17	$50.00	$259.20	$ 2.94	$12.31	$15.25	$ 47.25
18	$50.00	$319.50	$ 2.78	$14.97	$17.75	$ 60.25
19	$50.00	$399.00	$ 2.63	$18.37	$21.00	$ 79.50
20	$50.00	$500.00	$ 2.50	$22.50	$25.00	$101.00

Because inputs are fixed in the short-run there are also fixed costs. In the long-run there are no fixed costs.

Distinctions between short-run and long-run situations can arise in the determination of values that are critical to an analysis. For example, a navigation project would ideally compare the long-run marginal cost of moving commodities by water to the long-run marginal cost of moving them by, say, rail. Long-run marginal costs are difficult to measure because

Inflation

Inflation is a general rise in the price level. In a general inflation all prices tend to rise by roughly the same percentage. Inflation is frequently measured by a percentage change in an index number. Index numbers are weighted averages of the price of a specific set of goods and services. The Consumer Price Index (CPI) measures the weighted average price of goods and services purchased by a typical household. The Engineering News Record (ENR) indices measure the weighted average price of specific bundles of goods and services used in construction and building.

Inflation erodes the purchasing power of a fixed number of dollars. The table that follows shows the Federal budget deficit from 1980 to 1990. The deficit is shown in current dollars in the second column. The constant dollar deficit is shown in the third column. All the values in this column reflect 1982 price levels. The gross national product deflator, shown in column four, is the weighted average price of all final goods and services produced in the U.S.

FEDERAL DEFICITS

Year	Nominal Deficit	Real Deficit	GNP Deflator
1980	-61.3	-71.5	85.7
1981	-63.8	-67.9	94.0
1982	-145.9	-145.9	100.0
1983	-176.0	-169.4	103.9
1984	-169.6	-157.5	107.7
1985	-196.0	-176.7	110.9
1986	-206.9	-181.8	113.8
1987	-158.2	-134.8	117.4
1988	-141.7	-116.8	121.3
1989	-134.3	-106.3	126.3
1990	-161.3	-122.7	131.5

Source: Economic Report of the President, 1991.

at the time an analysis is undertaken there are bound to be many railroad inputs that are fixed in quantity. Over the next 50 years rail lines and storage facilities may be abandoned or added. How the quantities of these inputs may change over a 100 year period is pragmatically unknowable. Hence, it is often necessary to use short-run marginal costs in lieu of long-run marginal costs. This particular problem has been raised by a policy decision to use published rates rather than marginal costs. Thus, the analytical problem has been obviated.

In a planning context the demarcation between short-run and long-run is much fuzzier and more context dependent. Nowhere is this more obvious than in dealing with land values. Estimating the value of land is frequently plagued by short- run deviations from long-run trends. Suppose for argument's sake that a typical floodplain house has a long-run value of $75,000. Following a recent flood a study is initiated and the value of a floodplain house in the aftermath of the flood is found to be $50,000. What is the true value of the house?

In the short-run, which we can no longer define based on fixed inputs, buyers of property are strongly influenced by their knowledge of the flood threat. In the immediate aftermath of a flood there may be a tendency to overestimate the flood threat, thus depressing structure values below their true long-run value. Likewise, if there have been no floods in recent years, the threat of flooding may be underestimated resulting in inflated structure values in the short-run.

In a study that uses a 50- or 100-year planning horizon the NED cost of a property is its long-run market value. Long-run market

values should always be used when there is a deviation between the short-run and long-run market value. The practical difficulties are several, however. First, we are usually only able to observe short-run values. More fundamentally, we may not even know when the value we are observing is deviating from the long-run value. Second, it is difficult, if not impossible to estimate the long-run value. Lacking knowledge of long-run values, it is difficult to make proper adjustments to the short-run values we do have. Third, it may be strategically advantageous to use short-run values rather than to investigate the possibility of a deviation from long-run values. For example, housing values that are overstated or overestimated may lead to higher estimates of flood control benefits. Depressed property values make acquisition more attractive. Favorable situations are not always scrutinized as carefully as unfavorable ones.

Long-run and short-run considerations can become important when the phasing of project construction is considered. Design engineers sometimes have a choice between higher first costs of construction vs. lower operation and maintenance costs and lower first costs of construction vs. higher operation and maintenance costs. To illustrate, suppose you're building a house. You can make the exterior of painted clapboard which will hold down your costs now (short-run) and increase them in the long-run due to the need for regular painting; or, you can have vinyl siding installed. Siding will run up first costs (short-run) but hold down operation and maintenance costs over the long-term.

Project design is far more complex than house building, of course, but the types of trade-offs are very much the same in principle. If you are strapped for cash while building your house you may be tempted to hold down your short-run costs, anticipating that when those long-run costs come due you will be in a better position to bear them. Likewise, a project with a questionable benefit-cost ratio might have its economic feasibility enhanced by minimizing construction costs and pushing as many costs off into the future as possible.

g. Price Levels: Constant Versus Current Costs. Costs may be reported at today's price levels or at price levels from some other time period. If costs or other dollar values are going to be compared they must be at the same price level. For example, would you be better off making $6 per hour in 1966 or $24 an hour in 1990? We don't know, a priori, which is the greater sum of money because the price levels in 1966 were much lower than price levels in 1990. It's impossible to make a direct comparison between $6 in 1966 and $24 in 1990 because of price level differences.

A wage of $6 per hour in 1966 is equivalent to $18.52 based on a 1982-84 price level. A 1990 wage of $24 is worth $18.36 at the 1982-84 price level. Now that both wages are expressed in terms of the same price level we can compare and conclude that a $6 wage in 1966 yielded the higher standard of living.

Notice that the 1966 wage grows when expressed in terms of a time when prices were higher while the 1990 wage shrank when expressed in terms of a time when prices were lower. This is typical of what happens when prices are adjusted for changes in inflation.

A Pile of Stuff

Imagine a pile of goods and services piled high in the middle of a field. The value of that pile of stuff is figured by multiplying everything in the pile by its price and summing all these values. Suppose the pile of stuff was worth $1 million in 1980.

If another pile of stuff in 1985 is worth $1.5 million is it larger than the 1980 pile? The value of the 1980 pile depends on how much stuff is actually there and the price of each thing in the pile. It's possible that prices have not changed or have even fallen, in which case we can be sure the pile of stuff in 1985 is larger. If the pile of stuff is smaller then we know only price changes have caused the dollar value of the pile of stuff to increase. It's even possible that the pile is actually smaller and higher prices make its dollar value go up. If the pile is identical in size then prices have risen. It's also possible that the pile is a little larger and prices are a little higher.

When we try to compare dollar values from points in time with different price levels there are many possible explanations for the different dollar values. Just as there are different possibilities for the 1980 and 1985 piles of stuff.

Real or constant values can be thought off in terms of the real things the dollar values buy. Larger real values can purchase larger piles of stuff, i.e., more real resources.

Like the wage rate comparison, it is impossible to compare benefits at an October 1988 price level to costs at an October 1993 price level. Neither can we add a 1989 cost of land to a 1991 cost of concrete and get a cost estimate that has any real meaning. All values must be expressed at the same price level before they can be added or compared.

Dollar values are given in **nominal values** or **real values**. In the preceding example the $6 wage in 1966 and the $24 wage in 1990 are given in nominal or **current prices**, because the values are expressed in terms of the prices that prevailed in a given year. It is impossible to compare nominal values from different years, because of the different price levels. When the 1966 and 1990 wages are compared in terms of prices during 1982-84 we are using real or **constant values**. In this case the value of economic activity from another year is stated in terms of the prices in some agreed upon base year price level. The Federal government currently uses the price level that prevailed during 1982-84 as the basis for its Consumer Price Index.

In water resources planning all costs must be expressed in terms of the same price level. The preferred price level is the one that is prevailing at the time decisions must be made. Hence, the price level used by the Corps is generally as up-to-date as possible.

THE LANGUAGE OF THE CORPS

A Plethora of Terms

The result of the planning process is frequently a recommended plan of action. Implementing that plan of action is going to cost someone. An obvious question is, "How much is it going to cost?" A question of more interest here is, "What do we call that cost?"

A plethora of terms are used to describe the costs of a water resources

project. These terms are found in Army Regulations(AR), Engineering Manuals (EM), Engineering Pamphlets (EP), Engineering Regulations (ER), Technical Letters (TL), reports, and common usage. Over a dozen of them will be addressed here. Do they each mean something different? No! Do any of them have different meanings? Yes. Is it confusing? Absolutely!

To bring order to this chaos we need to go back to the Corps' dichotomous use of cost information. Cost information is needed for two fundamentally different purposes. First, cost information is needed to formulate water resource projects and to make economic efficiency decisions. Second, different cost information is needed to implement water resource projects and to make decisions about paying for the project.

In this section, we consider only this second need for cost information and how it emerges. The Corps' planning model is an evolutionary process that is carried out in stages of increasing detail. It begins with a reconnaissance study where the first estimate of cost is prepared. The **reconnaissance study** determines whether or not the identified problem has an economically feasible solution. If there is, the **feasibility study** continues the study process and identifies a recommended plan of action. A more detailed estimate of cost is prepared at this time. Following the feasibility study, the first stage in the **engineering and design** (E&D) process is called **preconstruction, engineering and design** (PED). The estimate of cost is refined during PED. The **plans and specifications** (P&S) that follow the PED work will result in further refinements of the estimate of cost. Finally, construction begins culminating in payment where, for the first time, the money costs of the project are known with certainty. Figure 8 illustrates this evolution of implementation cost data.

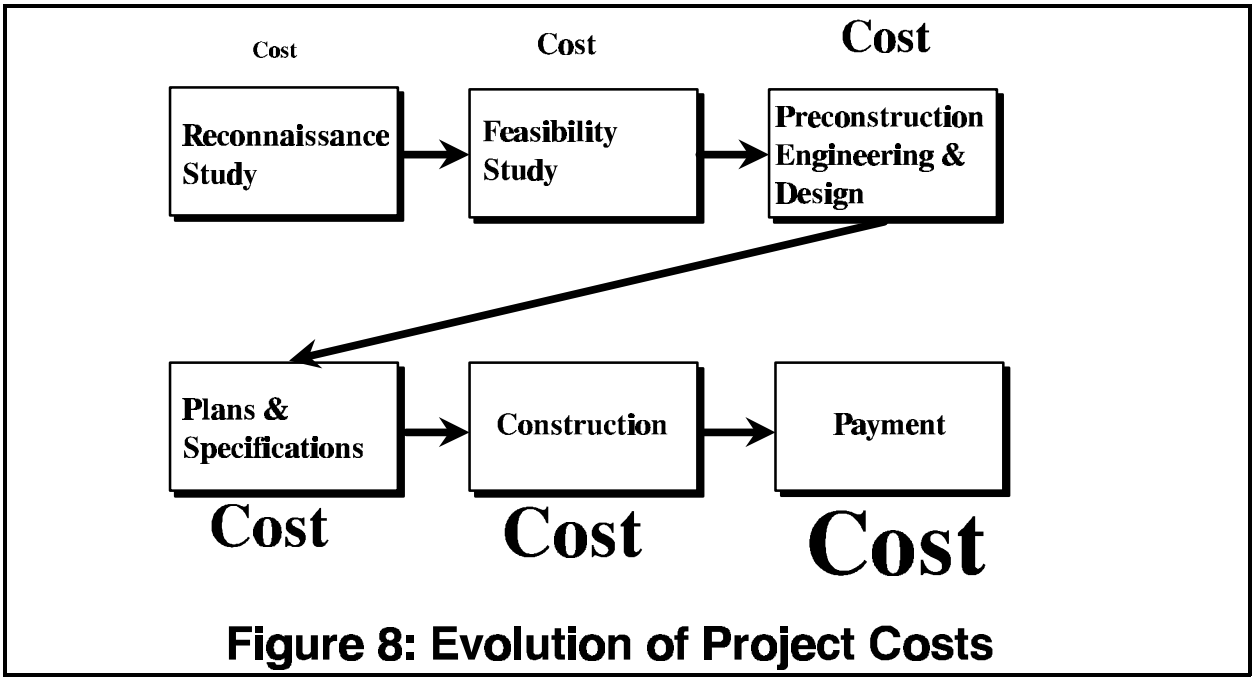


Figure 8: Evolution of Project Costs

Construction cost, first cost of construction, cost estimate, project cost, total project cost, project implementation cost, investment cost, gross investment cost, approved project cost, authorized project cost, fully funded cost, inflated cost, baseline cost and maximum project cost are some of the terms that have been or are used to describe the cost of implementing a water resource project. The actual term used to describe how much it will cost to implement a project vary from district to district and from office to office within the districts. This abundance of terms can make precise communication difficult.

Terms Used In This Manual

It's virtually impossible to find terms that are unambiguously clear in meaning, acceptable to all parties and in common usage. To standardize, simplify and clarify the Corps' language of cost in this manual, the three terms shown in Figure 9 are used. These are: **NED project cost**, **project cost**, and **baseline cost estimate**. The reader is cautioned that not all elements of the Corps use these terms in all applications.

a. NED Project Cost. The reconnaissance and feasibility studies report the results of the formulation and implementation analyses. Because of the differences in these two tasks there is no single cost estimate that meets all study needs. An estimate of the NED cost of each alternative project is needed to formulate plans, to determine if the projects are economically efficient, to select the NED plan[17] from among the alternatives, and to determine cost sharing percentages. The cost estimate that serves these purposes is called **NED project cost,** [18] i.e., these are the NED costs that are the focus of this manual.

* NED Project Cost
* Project Cost
* Baseline Cost Estimate

Figure 9:
Terminology of Manual

b. Project Cost. When the project team finishes its estimate of the cost of constructing and operating a project, long before costs are shared or price levels escalated, what is this estimate called? In this manual it's called **project cost** or, occasionally, implementation cost, when it's helpful to simultaneously emphasize the use to which the cost will be put.[19] These costs are expressed in terms of a given price level and they do not include any escalation of prices to account for anticipated future inflation.

The project cost at the time a project is authorized becomes the **authorized cost**. Project cost is the basis for most NED costs but project cost is not synonymous with NED costs.

c. Baseline Cost Estimate. The final term defined for this manual is **baseline cost estimate**. It has no relevance for NED cost analysis. They are used entirely for project implementation and management. The baseline cost estimate is the authorized cost plus estimated inflation from the time of authorization through the mid-point of the construction contract,

Baseline Cost Concepts

Suppose the authorized cost of a navigation project is $10 million at October 1990 price levels. If the mid-point of construction is 1994 and inflation for October 1990 through 1994 is estimated to be $1 million, the baseline cost estimate is $11 million. None of the inflation has been realized yet because the baseline estimate was prepared at the time of authorization. For simplicity assume inflation was estimated to be $250,000 per year.

By October 1992 we have been able to observe two years of inflation. Suppose inflation in the first two years was only $100,000 per year. Further suppose that inflation from October 1992 through October 1994 is expected to be $200,000 per year. The current fiscal year baseline cost estimate is the authorized cost ($10 million) plus actual inflation since authorization ($200,000) plus anticipated future inflation through the mid-point of construction ($400,000). In this case the CFBCE is now $10.6 million.

Following completion of simulator studies in 1993 some bends in the channel are redesigned and project costs are now estimated to be $11 million as of October 1993. Project redesign and the new cost estimate have been approved by higher authority. The CACE is obtained by taking the redesigned project cost ($11 million) and adding to it anticipated inflation through the mid-point of construction ($200,000 for the remaining year). The CACE is $11.2 million. It is also the fully-funded cost. Because redesign of the project requires a new cost estimate past inflation from October 1990 through October 1993 can now be ignored. Only inflation from the point of preparation of the new cost estimate on needs to be included.

hereafter called the mid-point of construction. Inasmuch as the baseline cost estimate is prepared at the time of authorization the entire inflation estimate is a forecast. Closely related to the baseline cost estimate are several variations described in the following paragraphs. The terms and definitions that follow are in common usage by the Corps.

The **current fiscal year baseline cost estimate (CFBCE)** differs from the baseline cost estimate in its handling of inflation. The CFBCE only has meaning after the original baseline cost estimate has been prepared. The CFBCE takes the authorized cost and adds to it the actual inflation that has occurred since the original baseline cost estimate was prepared through the point in time at which the CFBCE is being prepared. Next, inflation from the point the CFBCE is prepared through the mid-point of construction is estimated and added to the previous subtotal. An example is provided in the sidebar.

The CFBCE is the baseline cost updated to reflect price changes. As time passes, however, additional information may become available to the project team. If project design is improved or otherwise altered to reflect this new information a new cost estimate may be prepared. Once the cost of the project as it has been redesigned is estimated the **current approved cost estimate (CACE)** can be prepared. The CACE is comprised of the redesigned project cost plus the inflation forecast to accrue from the time the CACE is prepared through the mid-point of construction. The CACE is the **fully-funded project cost** if all of the redesign changes and their costs have been approved.

Other Terms New and Old

Over the years a number of terms have come into or passed from popular usage by Corps personnel. The meanings of some of these terms are not always clear. Most of them can be understood by the context in which they were used, but they lack formal definition. As a result, the meaning of these terms may vary from use-to-use. Some of them are discussed below.

a. Cost Estimate. Cost estimate has been used generically to mean whatever the user intends it to mean. The term should be avoided whenever precise communication is desired. However, in a proper context its meaning will probably be clear.

b. Construction cost. Construction cost or **first cost of construction** are two terms that have been used in the past to define the cost of implementing the recommended plan of action. Construction cost may sometimes be used to describe the expenditures, without inflation, required to build a project. These terms have fallen into some disfavor in recent years. First, because some recommended plans of action do not require construction. Changes in behavior, reallocation of water supply, changes in operating rules, etc. are examples of nonstructural plans that may not require any construction. Calling the costs of implementing such plans construction costs is clearly neither accurate nor descriptive. Second, some costs included among the costs of implementing a plan, such as planning, engineering and design (PED) costs, are not actual construction costs.

c. Investment Cost. As it became evident that construction cost was no longer serviceable in all contexts, project cost came into use. At the same time, investment cost began to be used by some to describe the outlays required to implement a project. Investment cost is roughly synonymous with current project cost. At about the same time, some people began to distinguish between **net investment cost** and **gross** or **total investment cost**. Gross or total investment cost has been used to represent the sum of net investment plus interest during construction.

Interest during construction (IDC) is an equivalence adjustment made to NED costs. It is not a money cost and is never actually paid by any party to the project. IDC is considered further in Chapter 5. All the investment cost terminology can be retired from usage.

d. Language for the Non-Federal Partner. In recent years, as the non-Federal share of project costs has grown larger, the need has arisen to assist the non-Federal partner to plan for paying their share of the costs. The non-Federal partner is most interested in knowing how many dollars they will have to pay at a certain point in time. To tell them that a project that will be built in eight years time would cost them $25 million if it were built today is not useful information. The non-Federal partner needs to know how much the project will cost them when it is actually built.

This need has given birth to a new generation of cost jargon, those that project future costs of plans. Local interests need to know what their dollar obligations will be from year-to-year for the project. This requires a cost estimate that takes inflation into account. **Inflated cost** was one of the first terms used to represent the cost of a

Authorization and Costs

An important milestone in every Corps study is passed at the time a recommended plan is authorized by Congress. By authorizing a project for construction Congress clears the way for Appropriations Committees to fund the project. It also unleashes a new wave of cost jargon on parties to the authorized project.

Authorized cost or **authorized project cost** is the cost contained in the public law that authorizes the implementation of the project. This cost never changes in that it is published in the legislation and can be "looked up."

A final term worthy of mention is **maximum project cost**. In the past, the Corps has been criticized for extensive cost overruns. Another version of this criticism leveled during the 1960s and 70s was that the Corps underestimated the cost of projects in its planning stage in order to assure a "healthy" benefit-cost ratio. Once authorized, project costs would rise as a result of design changes made necessary by the strategic underestimation of costs.

To address these types of criticisms, maximum project cost was created by **Section 902** of the Water Resources Development Act of 1986 (WRDA '86). It placed a 20 percent limit on cost overruns beyond the authorized cost. The maximum project cost consists of three components: 1) the project cost (as defined above); 2) the current cost (i.e., unadjusted for inflation) of any studies, modifications, and action authorized by WRDA '86 or any subsequent law; and, 3) 20 percent of the authorized cost[1]. In essence, the method for calculating maximum project cost, found in Appendix P of ER 1105-2-100, makes a full allowance for increases in the authorized cost due to inflation. Increases in costs due to changes in design or changes in prices in excess of those estimated (plus

(Continued)

inflation) are limited to 20 percent of total project cost. If project cost exceeds the maximum project cost, the project must be reauthorized. To determine the Section 902 limit divide the CACE by the CFBCE. If the result is greater than 1.2 the project must be reauthorized.

In the example presented in the preceding sidebar the ratio of CACE to CFBCE is 1.06, less than the Section 902 limit.

1. This definition is taken from page 2-51 of ER 1105-2-100 dated 12/28/90.

project with price level increases due to inflation and it is still in use.

Perhaps the term most frequently used to represent actual dollar requirements is **fully-funded cost**. Fully-funded cost is a money cost, not an NED cost. Its main usage is in cash-flow analysis and it is used most frequently when dealing with non-Federal partners in the development of a PCA. The term is not without its critics, however. Some elements of the Corps feel the term implies that all of the money needed for the project is available and waiting to be spent. This does not accurately describe the way that Corps projects are funded.

Recurring Cost Concepts

The preceding discussion dealt with the costs of putting the water resource project in place. There are many other costs related to

the project in addition to the cost of putting that project in place. Among these are the costs of keeping the project in good condition. **Operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs** are the costs of all the activities required to make the project work as designed to realize the benefits identified during the planning phase of project development throughout the life of the project. Some of them are regular and predictable costs, e.g., cutting the grass every month during spring and winter; and some of them may occur at erratic intervals in unpredictable ways. An example of this might be the need to replace a miter gate at a lock that was damaged unpredictably by a tow.

OMRR&R costs are expressed as a recurring annual expense for purposes of economic efficiency determinations. Because OMRR&R is expected to last the life of the project, often running to 100 years, current dollar estimates of OMRR&R costs for those "out years" are not estimated and OMRR&R costs are expressed at the same price levels as the current project costs. For example, annual OMRR&R costs of $200,000 at 1992 prices imply that whatever the nominal costs of OMRR&R are they will be roughly equivalent to $200,000 at 1992 price levels. Suppose $200,000 in 1992 pays for 3 employees, mowers, fuel, a smattering of tools and spare parts. These resources are the real costs of OMRR&R and the nominal cost will depend on the cumulative effects of inflation. The party responsible for OMRR&R can expect to have to pay whatever it costs for 3 employees, mowers, fuel, a smattering of tools and spare parts in any given future year.

Operation and maintenance costs are routine and fairly predictable. Replacement

Cost Allocation

As the foregoing discussion shows, different project purposes have different cost-sharing percentages. When a project serves two or more project purposes with different cost-sharing percentages it is necessary to allocate the separable costs of the project to the different purposes served. For example, a lock and dam might provide hydropower, navigation, recreation and flood control outputs. In this case, all the costs of the lock and dam must be allocated to one purpose or the other. The costs allocated to each purpose are then shared between the Federal and non-Federal partners according to the applicable cost-sharing percentages.

NED costs are used to determine the percentage of project costs allocated to each project purpose. Project costs, not NED costs, are the costs that are shared by the planning partners.

The **separable costs remaining benefits** (SCRB) method of allocating costs is the preferred cost allocation procedure. The SCRB method was recognized in the Inter-Agency Agreement of 12 March 1954 among the Departments of the Army and Interior and the Federal Power Commission as the preferable method for allocating costs. Acceptable alternatives to the SCRB method are the Alternative Justifiable Expenditure Method and the Use of Facilities Method. These methods are described, with examples, in the April 1959 "Laws and Procedures Governing Conduct of the Civil Works Program," a statement prepared for the Committee on Appropriations in the House of Representatives, 86th Congress, 1st Session.

The SCRB method has spawned a vocabulary of its own that includes **alternative costs, joint-use costs, joint costs, separable costs, and specific costs**. These terms are defined in *Chapter 6 Section XV - Cost Allocation of* ER 1105-2-100.

costs are large expenditures that are incurred infrequently but at predictable intervals. For example, a crane needed to install stop logs in a flood control closure structure may have to be replaced every twenty years or so. This is a regular expenditure that is distinguished from ordinary O&M activities by both its magnitude and the length of its recurrence interval.

Over time, projects deteriorate physically because of weather, usage, accidents and a host of other factors. Correction of these long term cumulative effects is often beyond the means of ordinary O&M activities. As projects deteriorate, their performance may fall below design standards necessitating replacement or a major effort to rehabilitate the project to its original performance conditions. The efforts required to do this and the costs incurred in their performance are considered rehabilitation costs.

Micro-Computer Aided Cost Estimating System (M-CACES)

All official estimates of cost necessary for implementing a water resource project are to be prepared using the Corps' Micro-Computer Aided Cost Estimating System, better known as **M-CACES**. [20] Many in the Corps have begun to refer to the project cost estimate as the M-CACES cost. Others refer routinely to the M-CACES cost estimate. M-CACES is a software package used to prepare cost estimates that allows project managers and others to carefully track changes in cost estimates as a management tool. An M-CACES cost estimate is a misnomer, there is no such thing. What people mean when they refer to an M-CACES cost estimate is a cost estimate prepared using the M-CACES software package.

The reconnaissance study results in the first cost estimate using M-CACES. A code of accounts has been identified within M-CACES and planners must select the appropriate accounts and level of detail necessary to support the scope of the study. The M-CACES system is used from the reconnaissance study through project completion.

Cost-Sharing

Once a project cost estimate has been prepared, the next questions are, "Who pays construction costs and who pays the OMRR&R costs?" Some costs will be paid by the Federal government. Other costs will be borne by non-Federal interests. Project cost is divided into **Federal cost** and **non-Federal cost**. **Cost-sharing** or **cost apportionment** is the practice of dividing the responsibility for paying the costs of a project between Federal and non-Federal interests.

Formulas determining the shares of construction costs vary depending on the purpose of the project. Table 3 summarizes selected construction cost-sharing responsibilities. These are a matter of public policy currently determined by the Congress. Most of the time, OMRR&R costs are 100 percent non-Federal costs but there are exceptions. A detailed explanation of the current cost-sharing percentages for construction and OMRR&R for most project purposes can be found in Appendix F of ER 1165-2-131.

TABLE 3: SELECTED NON-FEDERAL COST-SHARING PERCENTAGES	
Navigation - Harbors	20%: depth < 21 feet 25%: depth 21 - 45 feet 60%: depth > 45 feet
Navigation - Inland	50%
Flood Control: Structural Nonstructural	 Min. 25% - Max 50% 25%
Hydroelectric Power	100%
M&I Water Supply	100%
Agricultural Water Supply	35%
Recreation: Navigation Other	 50% 50% of separable cost
Hurricane & Storm Damage	35%
Aquatic Plant Control	50%

As Table 3 indicates, the split of costs between Federal and non-Federal interests varies depending on the purpose of the project. When a project serves more than one purpose, cost-sharing can get a little complicated. The first step required in determining cost shares is to allocate the costs of the project to the different purposes served. **Cost allocation** is the process of equitably distributing project costs among authorized project purposes, or those proposed for authorization. Once costs have been allocated, those costs can be shared according to the existing cost-sharing responsibilities.

Table 4 illustrates how cost-sharing proceeds after cost allocation. A $100 million project provides flood control, hydropower and agricultural water. The $100 million must first be allocated to each of these project purposes. Using the SCRB method it has been determined that half the costs are attributable to flood control and a quarter each are allocated to hydropower and agricultural water.

Once costs have been allocated, as shown in the "Total" column, they must next be allocated or shared by the two project partners. In this example, the non-Federal partner must pay a total of $46.25 million for the project. They are responsible for $12.5 million of the flood control costs, all $25 million of the hydropower costs and $8.75 million of the agricultural water costs.

Alternative cost

There are usually one or more alternative ways to produce the output yielded by a project. When one of these alternatives is the focus of a planning study, **alternative cost** is defined as the cost of the most likely alternative means of providing the same or an equivalent level of output.

TABLE 4: EXAMPLE OF COST ALLOCATION & COST-SHARING ($ Millions)			
	Total	**Federal Share**	**Non-Federal Share**
Project Cost	100	53.75	46.25
Flood Control	50	37.5	12.5

The alternative cost is used as a measure of benefits when better measures are not available. Estimating benefits in this manner presupposes that a decision has been made to provide the outputs afforded by the water resource project. It also presupposes that if the water resource project is not implemented decision makers will then implement the second best alternative. Alternative costs are often used with water supply and hydropower project evaluations.

Life-cycle costing is a relatively new term for a concept the Corps has followed for many decades though the term is rarely used by Corps planners. Life-cycle costs is normally defined as the sum of all expenditures associated with a project from its inception to its disposal or salvage. The focus is on direct and indirect cash flows over the life-cycle of the project. The life-cycle stages of a typical project are shown in Figure 10.

COST AS THE BASIS FOR BENEFITS

Costs are sometimes used as the basis for estimating project benefits. **Cost savings** and the **cost of the most likely alternative** are two types of benefits based on costs. When a project makes it possible to produce existing levels of output with fewer resources, the value of the saved resources is a project benefit. If prices accurately represent the value of the saved resources, then the reduction in the costs of those resources is the benefit. For example, if it costs $2 to produce a bushel of wheat without a project and $1.50 to produce the same wheat with the project, there is a $0.50 per bushel cost savings. There is a benefit because fewer resources are required to produce the wheat. The value of these resources is estimated to be $0.50.

Estimates of the value of a project output are based on consumers willingness to pay[21] for the output. One of four potential measures of willingness to pay suggested by the P&G is the cost of the most likely alternative.[22] When

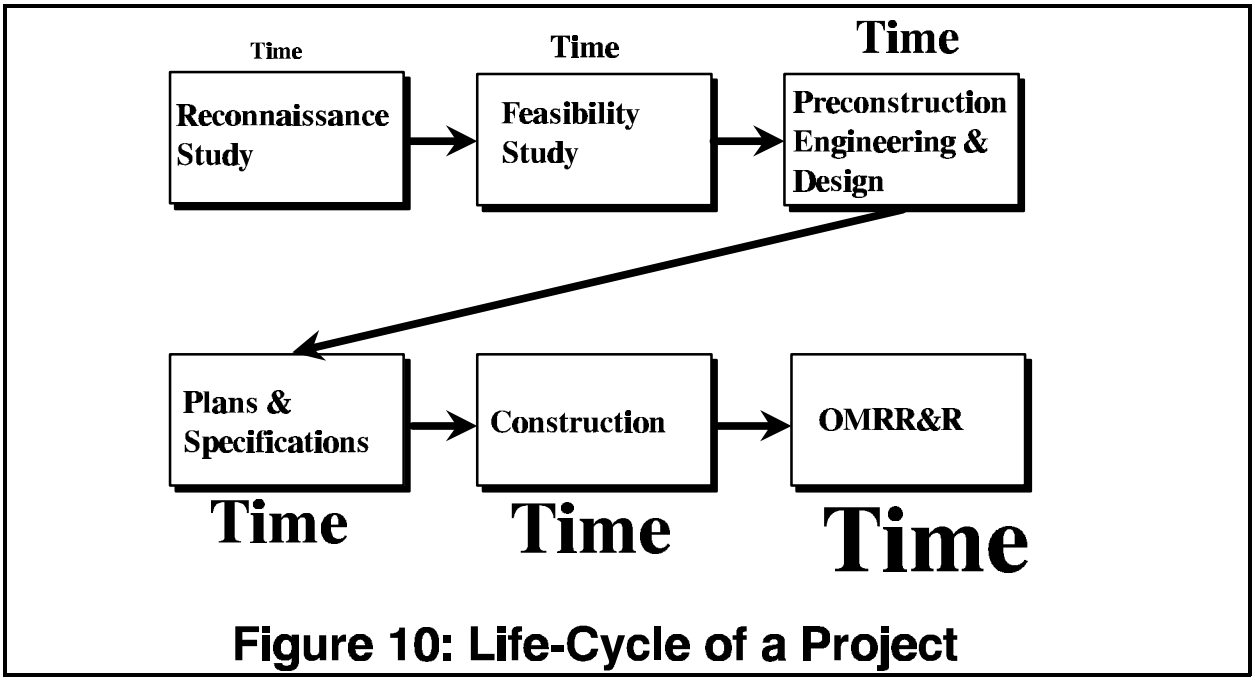


Figure 10: Life-Cycle of a Project

a good is sufficiently important that a decision has been made to provide it, there is no need to estimate project benefits. Economic efficiency, under these circumstances, requires that the least costly way of providing the good be used. The value of the project's output is sometimes approximated by the cost of the alternative that will be used to produce it if the project under consideration is not implemented.

For example, suppose a community has decided that its electrical power capacity will be increased. Further suppose the community was planning to build a thermal generating plant at a cost of $700 million. If a water resource project can provide the same capacity at a cost of $500 million, then the cost of the most likely alternative to the hydropower is the thermal plant at $700 million. In the absence of better information, this cost can be used as an estimate of the value of the power capacity, i.e., project benefits.

Costs play a role in the estimation of other benefits as well. For example, inundation reduction benefits are nothing more than the cost of resource losses averted. Navigation benefits include reductions in the costs of transporting goods. Vessel operating costs figure largely in these reductions. Any project that lowers the marginal costs of production results in a shift in the supply of the output and produces benefits. These issues have been addressed in the *National Economic Development Procedures Manual- Overview Manual for Conducting National Economic Development Analysis*.

SUMMARY AND LOOK FORWARD

Scarcity, choice and opportunity costs are some of the basic notions that underlie the economists notion of costs and the planners notion of NED costs. After briefly considering these notions, we looked at three major uses for cost information within the Corps program: formulation, implementation and budget. Though the last of these is not considered in this manual, we have seen that the first two functions may be hampered by the existence of what amounts to two different dialects in the language of costs.

Understanding a little something about the language of economists and the language of Corps personnel is necessary for evaluating water resource projects or dealing with those who do. One cannot understand NED costs without knowing the language of those that use them. The more commonly used and more important cost concepts have been introduced and discussed in this chapter. In the next chapter we build on the concepts introduced here to develop a more complete understanding of NED costs and its component parts.

Chapter 4: NED COSTS

CHAPTER OVERVIEW

Water resources projects involve many different interests: the Federal government, state and local governments, environmentalists, homeowners, farmers, fishermen, etc. Each may have its own unique perspective about the costs and benefits of the project. Which group has the right perspective? Because the determination is subjective and very personal, each does. There is no right or wrong perspective, only different perspectives. Each serves a different purpose. It has been determined by the policy set forth in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)* of March 1983 that one perspective Federal water resources agencies take is the perspective of national economic development.

The NED perspective is very different from the non-Federal partner's perspective. From the NED perspective, if a factory employing 2,000 leaves Midvale to relocate in Smallville as a direct result of a water resource project in Smallville, there is no benefit or cost to the national economy.[23] Midvale loses 2,000 jobs, Smallville gains 2,000 jobs and the net change in jobs is zero. True enough, but the Mayor of Smallville will be wearing a big grin on her face while the mayor of Midvale will frown. The facts of the situation are immutable, the perspectives are very different.

Some people disagree with the NED perspective. That is understandable. It is also irrelevant, because use of the NED perspective in identifying the costs to consider in economic efficiency questions is mandated by National policy. Federal agencies, representing the nation, ask "What's this going to cost?" before they write a check for the project. Using the NED perspective is, pure and simple, what non-Federal partners must put up with in exchange for Federal water resource development dollars.

Figure 11 previews the structure of this chapter which mirrors the organization of P&G Section XII-NED Cost Evaluation Procedures.

CONCEPTUAL BASIS (2.12.2)

The P&G defines NED costs as "..the opportunity costs of resource use." Thus, it is the apparent intention of this policy that NED costs be as true to the economic concept of opportunity costs as possible. NED costs are to include all private and social costs. [24] The conceptual basis for NED costs is found in economic theory and not in financial, legal, psychological or any other definition of costs.

Opportunity costs and money costs are not necessarily the same thing. Opportunity costs may exceed money costs by a substantial amount. Other times money costs may exceed opportunity costs. Fortunately, when markets are competitive and work well, opportunity costs and money costs, or price, are the same thing.

1. **Chapter Overview**
2. **Conceptual Basis**

    a. Opportunity cost of resources
    b. Market values
    c. Nonmarket values
    d. Annual values

3. **Planning setting**
4. **Evaluation procedure: General**

    a. What is and isn't an NED cost
    b. Price level
    c. Salvage value

5. **Evaluation Procedure: Implementation Outlays**

    a. Postauthorization planning and design costs
    b. Construction costs
    c. Construction contingency costs
    d. Administrative services costs
    e. Fish and wildlife habitat mitigation costs
    f. Relocation costs
    g. Historical and archaeological salvage operation costs
    h Land, water, and mineral rights costs
    i. Operation, maintenance, and replacement costs

6. **Evaluation procedure: Associated Costs**
7. **Evaluation procedure: Other Direct Costs**
8. **Evaluation procedure: Problems in application**
9. **Evaluation procedure: Data Sources**
10. **Report and display procedures**

Market prices are determined by the interaction of supply and demand as shown in Figure 12.[25] If we interpret the demand curve as a marginal benefit (MB) curve and supply as a marginal cost (MC) curve [26] then it is easy to see that the optimal amount of the good is obtained at $Q.^*$ This follows from the principles of marginal analysis, summarized in the preceding chapter. For quantities less than this, marginal benefits exceed marginal cost and society is better off to produce more of anything for which this is true. For quantities greater than $Q,^*$ marginal costs exceed the marginal benefits and society would be better off to produce less of such goods.

Unfortunately, markets do not always work well. When they don't, prices do not represent opportunity costs. Commonly recognized market failures result from the existence of monopoly power, public goods and externalities. Figure 13 shows the case of market failure due to negative externalities. Marginal social costs (MSC), i.e., the all-inclusive opportunity costs, may equal or exceed marginal private costs (MPC). In the figure, MSC exceed MPC at every quantity.

For simplicity, marginal social benefits (MSB) are assumed to equal marginal private benefits (MPB). If some costs, say the costs of pollution, can be ignored by the producer a quantity of Q_P will be produced at a price of P_P If all costs were considered, the efficient output would be Q_S at a price of P_S Thus, a market that does not charge for pollution costs will undervalue and overproduce the good. The observed price, P_P, will be below the true cost to society, which is P_S At Q_P MSC > MSB and society is overproducing.

When the market price of a good does not represent its true marginal value it is necessary to estimate the true cost by other means. This can be done through the use of **shadow prices**, discussed at the sidebar. Shadow prices can be estimated using **surrogate values**. An example of a surrogate value is to use the price from a similar situation. For example, the value of water in a community that uses rates intended to approximate the average cost of

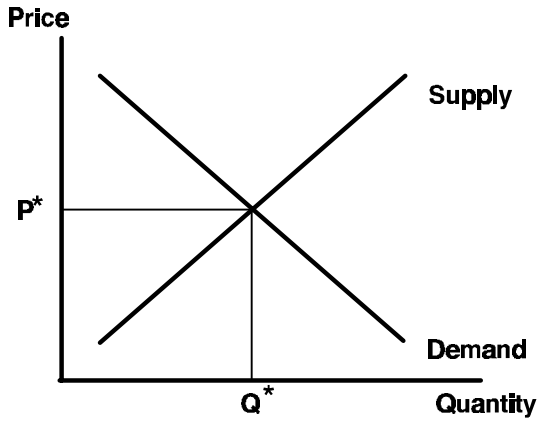


Figure 12: Price Determination

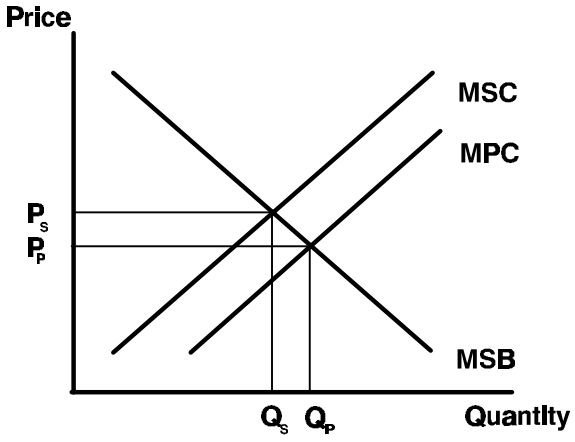


Figure 13: Market Failure

Shadow Prices

A profit maximizing business evaluates a project in what we can classify as two distinct steps. First, all the physical consequences of the project, i.e., the inputs to and the outputs from the project, relevant to the business are assessed. Second, these inputs are converted into costs and the outputs to revenues using market prices. For the business, market prices are relevant because these are the prices at which transactions take place and profits are made.

When government evaluates a project it differs in its approach to these two steps. First, government is interested in all the consequences of the project, however indirect. A point made in the preceding section. Second, government will use prices that reflect social costs and benefits. If they deviate from market prices, the market prices are irrelevant. What is desired is the shadow of those prices that reveal all relevant costs.

When market prices reflect social value there is no need for shadow pricing. Shadow pricing is required when market prices exist but are biased or when market prices do not exist. Market prices may be biased by monopoly power, unemployed resources, nonmarginal price changes, increasing returns to scale, taxes and subsidies, price controls, and externalities. Market prices may not exist for public goods, non-market goods, and externalities.

providing the water, will not represent the true value of the water. The true value might be estimated using the price of water from a neighboring community where competitive water markets exist. Shadow prices can also be estimated using rules of thumb,[27] mathematical programming, lagrange multipliers, and a variety of other techniques that are beyond the scope of this manual.

PLANNING SETTING (2.12.3)

Costs are identified using the same without project and with project condition scenarios comparison that is used throughout the planning process. To identify the costs of a project it may be helpful to ask, "What does society lose as a result of this project?" Once the real resource losses can be identified, they must be valued at their opportunity cost using market prices or shadow prices.

EVALUATION PROCEDURE: GENERAL (2.12.4)

The evaluation procedure outlined in the P&G is presented in five parts. First, general considerations are discussed. These are primarily concerned with the basic nature of NED costs and the need to use equivalent dollar values (discussed at length later in this chapter) in project evaluation. NED costs are, in essence, separated into three types; explicit project costs are called implementation outlays; implicit project costs are called other direct costs; associated costs are unique to the NED cost lexicon. Each of these cost types will be discussed in turn. The final subject of the evaluation procedure discussion is problems encountered in applying the NED concepts. Though this is the specific theme of Chapter 5, an initial treatment is offered in the following paragraphs.

WHAT IS AND IS NOT AN NED PROJECT COST (2.12.4(A))

Chapter 5 considers a number of cases that distinguish NED and non-NED costs in specific circumstances. In this

section the narrower view of the question as raised in the P&G is considered. Consistent with the conceptual basis for NED costs, only costs incurred as a direct or indirect result of the project are properly considered NED project costs. The costs of any feature of the project are definitely NED costs. If any feature of the project affects resources in another area an NED cost results. There is, however, an entire class of economic/ opportunity costs that are not part of the project NED costs. This class of costs depends on whether or not the cost under consideration results from a required feature of the project.

Non-Federal partners may want to take advantage of work being done as part of the water resource project to improve the delivery of other goods or services. For example, widening a channel for flood control may require replacement of a one-lane bridge. Local interests may want to take advantage of the situation to widen the bridge to two lanes. The additional cost of going from a one-lane to a two-lane bridge is not a feature of the project that is required for project purposes, so it is not a project-related NED cost and it should not be included in the economic analysis. Neither would the Federal government bear any cost for the widening of the bridge.

A more theoretically faithful treatment of this situation would include the costs of the new bridge as well as the benefits that accrue to it in the economic analysis of the project. Because the bridge and channel serve separate purposes, cost allocation would be warranted. A policy decision has been made to limit economic evaluation to only those parts of the project that are essential to the project's functioning as designed. While crossings over a flood control channel may be essential to the project, a second lane on the bridge is not. In effect, by ignoring costs that are not essential to project features, the Federal government is leaving the determination of the economic feasibility of non-essential features to non-Federal interests.

In planning practice the cost of replacing the bridge is the most commonly used estimate of the value of the bridge. The cost of producing a good is, however, not the measure of the good's value in a market economy. Value is determined by supply and demand. The cost to replace a bridge addresses only the supply side of the market. As with any resource, the true value of the bridge is total willingness to pay for it. In the absence of any such estimate of value, the cost of in-kind replacement of the bridge is often used. This is another policy determination that relieves analysts of the need to make a true economic determination of the value of the resource.

Project construction may provide local interests with an attractive opportunity to improve other existing infrastructure. Any such **betterment** that is incidental to the design and function of the project shall be considered not project-related. Betterment costs will be excluded from NED project costs even though they may represent explicit or implicit opportunity costs.

In the case of a betterment, where an existing bridge, road, or utility line is replaced by an improved[28] bridge, road, or utility line the true economic cost to the project is the value of the resource displaced by the essential project feature. Thus, if a one lane bridge is removed and replaced by a two lane bridge, the cost to the project is the value of that one lane bridge. The value

of the second lane is a betterment and its cost is more properly attributed to improved transportation than to flood control. Current Corps policy differs from this economic view. Policy establishes the value of the bridge as the cost of replacing a one lane bridge using today's engineering design standards. This is considered replacement in-kind though it may actually result in an improved bridge. Anything more than this is considered a betterment.

With the changes in cost-sharing and the planning process that have taken place since the P&G were written, a second issue comes up frequently when cost-sharing is determined. The non-Federal partner is responsible for all utility road replacements so there is no question about who will actually pay for the two lane bridge that replaces the one lane bridge. The real bone of contention is how much credit toward their share of the project costs will the non-Federal partner get for replacing the bridge. Thus, there is a "who pays how much" issue in addition to the economic efficiency/NED cost issue.

Suppose the two lane bridge costs $10 million; how much of that $10 million will count as part of the non-Federal share of project costs? The first issue is why is a two lane bridge being built? If local interests prefer an improved bridge then we have a betterment. If a two lane bridge is being built because this is the basic engineering design standard for this situation, there is no betterment. The two-lane bridge is considered a replacement in kind. In the latter case the entire $10 million is considered part of NED costs and the non-Federal partner gets credit for the entire $10 million. If, on the other hand, a one lane bridge built according to today's engineering design standards costs $5 million, then the non-Federal partner gets credit for $5 million. The project related NED costs are $5 million. The additional $5 million is not a project-related NED cost and the locals will receive no credit for the cost of this betterment.

PRICE LEVELS AND TIME REFERENCE OF NED COSTS (2.12.4(B))

All project costs are to be current as of the time of the analysis. This means that a cost estimate prepared in 1992 should be expressed in 1992 dollars, rather than in 1980 or 1995 dollars. Once the price level is determined, however, that price level must be used for all monetary estimates of benefits and costs. This is the requirement to use constant dollars. Subsequent updates of price levels shall adhere to the constant cost requirement of expressing all monetary values at the same price level.

All costs are to be discounted or compounded [29] to the end of the installation period. This corresponds to the time at which the project is functionally capable of producing project benefits, also known as the base year.

Price Level

The P&G says that all NED costs are to be based on "..current costs adjusted by the project discount rate to the beginning of the period of analysis." The P&G goes on in the next sentence to direct analysts to "Compute all costs at a constant price

level [30]." The terminology used in the P&G seems to imply a contradiction in their direction about what price levels to use. That is not their true intent. The language used in this section of the P&G can be confusing if it is interpreted in a literal economic sense.

Current costs are the costs that prevail at the time the cost is incurred. For example, the current cost of admission to a movie theater in 1960 was $0.20; the current cost in 1992 is $6.50. Costs of a 1960 admission are expressed in 1960 price levels and a 1992 admission is at 1992 price levels. These are current costs and cannot be directly compared.

Constant costs express costs in real terms that have been adjusted for differences in price level so they might be properly compared. The price of a movie in 1960 is about $0.97 at 1992 price levels. Using constant costs, i.e. 1992 price levels, we can easily see that a movie is about seven times more costly in 1992 than it was in 1960.

Price level guidance contained in the P&G is not meant to be strictly interpreted in light of these definitions. NED cost estimates should be prepared using price levels from the current year of the study. In 1992, 1992 price levels are used, in 1993, 1993 prices are used and so on. This is done to ensure that the same relative price levels have been used for all resources used in project construction. When possible prices are expressed as of October 1 of the current year. No matter when a cost is incurred during the period of analysis it will be expressed in one and the same price level, say, October 1, 1992. This is what is meant by the P&G direction to use current prices.

Planning Horizon

To express monetary values at the same point in time requires an understanding of the relevant time lines involved in the planning process. Figure 14 shows a hypothetical planning horizon broken into four segments. First, there is the study period, here defined to mean that period of time from the initiation of the study to the initiation of project construction. Second, is the construction period, called the installation period in the P&G. [31] The installation period is defined as the number of years it takes to install the project.

The period of analysis (the third segment), also known as the economic life of the project, is defined as a matter of policy. The definition of period of analysis contained in the P&G [32] differs from the definition in common usage. The preferred definition effectively defines the period of analysis to exclude the construction/ implementation period. It begins with day one of the base year and extends 50 or 100 years into the future. It is Federal policy to use a 50-year period of analysis except for large multi-purpose lakes, major long-term urban flood protection and main-line agricultural levees and hurricane protection for which a 100-year period of analysis can be used.[33]

The project life, the fourth segment, is a period of time that a normally operated and maintained project will continue to function as it was designed to do. The project lives of most water resource projects are generally assumed to exceed the period of analysis.

In order to compare benefits and costs that accrue unevenly over this planning

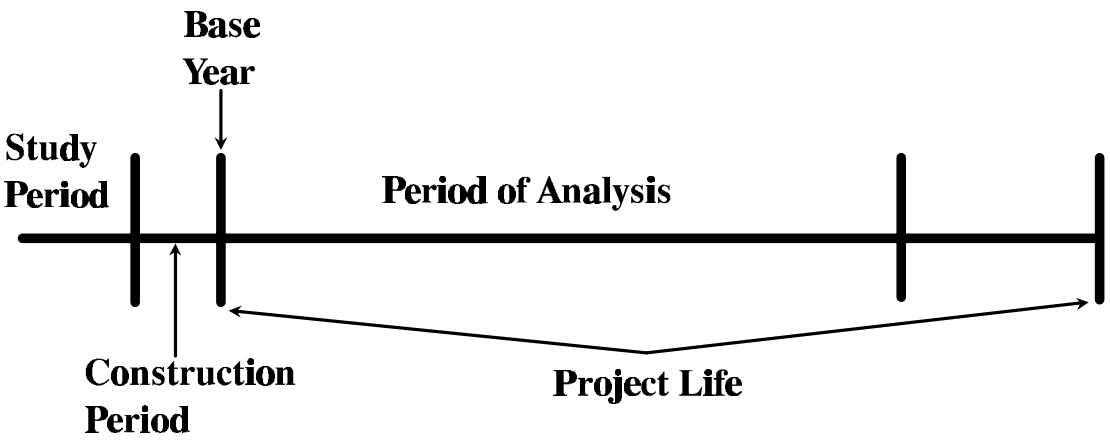


Figure 14: Planning Horizon

horizon we must select an arbitrary point in time at which these values will be compared. That point in time is the beginning of the **base year** and is shown on the figure. The working definition of the base year is that point in time at which the project is functionally operational. Usually the base year coincides with the end of the construction/installation period. The base year is the first year of the period of analysis. These segments of the planning horizon and the base year become significant for the calculation of growth and discounted monetary values.

Time Value of Money

Project costs typically occur in a few large installments over the construction period. A smattering of OMRR&R costs are incurred over the remaining project life. Benefits, on the other hand, do not usually begin to occur until after project construction is completed. Occasionally, benefits can accrue before the base year but benefits generally occur at regular or random intervals over the period of analysis. To compare these different streams of monetary values [34] we must adjust for the time value of money. Dollars that occur at different periods in time cannot be directly compared to one another even if they are expressed at the same price level.

Given a choice between $10,000 today and $10,000 one year from now which would you choose? Most people would choose to have the money now. Why? As with other choices we evaluate the options and choose the one worth more to us. Money in the present is always worth more then the same amount of money in the future. If the interest rate is 10 percent $10,000 now, saved at 10 percent, would be worth $11,000 a year from now. Clearly, $10,000 today is more valuable than $10,000 a year from now, or at any point in the future because of its ability to grow if it is profitably invested or saved.

Standing the previous example on its head, we might ask, what would you rather pay, $10,000 now or $10,000 a year from

Annuity

An **annuity** is a stream of equal annual cash flows. These cash flows can be outflows of funds invested in order to earn future returns or inflows of returns earned on investments.

Annuities are used in two basic ways. First, we might ask how much we would have to save to have a specific amount of money at some point in the future. In this case we know the future value and seek the annuity required to cover it. For example, if we need $5,751 five years from now and the interest rate is 7 percent, we would require an annual annuity of $1,000[1]. Suppose the future cost of the project is $5,751, what is the minimum annual payment required to cover this cost? It would equal the $1,000 annual annuity.

Second, we might ask what $1,000 a year for five years is worth when the interest rate is 7 percent. In this case we know the annual value and want to know what it is worth today. Suppose, for example you are offered the opportunity to buy a water resource project that will produce a cash flow of $1,000 per year for five years. How much would you pay for it? It turns out that if you had $3,993 today you could invest it at 7 percent interest and draw out $1,000 per year for five years[2].

Annuities are annual values that are frequently used to reduce lump sum future or present values to a flow of money over a number of years. Annual sums of money have intuitive appeal for most people.

1.$(\$1,000)(1.07)^4 + (\$1,000)(1.07)^3 + (\$1,000)(1.07)^2 + (\$1,000)(1.07)^1 + (\$1,000)(1.07)^0 = \$5,751.$

2.$(\$1,000)(1.07)^{-1} + (\$1,000)(1.07)^{-2} + (\$1,000)(1.07)^{-3} + (\$1,000)(1.07)^{-4} + (\$1,000)(1.07)^{-5} = \$3,993.$

now? If you pay the $10,000 now you have nothing left over. Save the $10,000 for a year then pay it and you can keep the interest and are $1,000 better off than you would have been had you paid now. Faced with the receipt of equal sums of money at different points in time it's better to take the money as soon as possible. Faced with the payment of equal sums of money at different points in time, it is better to delay payment as long as possible. Intuitively, we all recognize money at different times has different value.

How, then, do we compare different monetary values that occur at different points in time? Suppose the interest rate is still 10 percent. Would you rather have $10,000 today or $10,500 in a year? How about $10,000 or $11,200? Given the information above, we know $10,000 today is worth $11,000 in a year. All we need to do is compare this to value offered one year hence. Because $10,500 a year from now is less than the $11,000 we'd have in a year if we receive the $10,000 now, we'd take payment now. On the other hand, $11,200 in a year is more than we could make if we took the $10,000 now, so we prefer the future payment.

The process of taking a value in the present and projecting its value in the future is a simple growth calculation.[35] We take the principle ($10,000) and add to it the interest (10%) received. The simple computation is:

(1) $10,000 x (1 + 0.1) = $11,000

This tells us that any future value in excess of $11,000 is worth more to us than $10,000 now. A value less than $11,000 is worth less and $11,000 in a year is worth exactly

Compounding

Benjamin Franklin at his death in 1790 left £1,000 to the city of Boston under the condition that it not be touched for 100 years. The bequest, equal to about $4,600 at the time, grew to $332,000 by 1890. People do not have to live to be 100, however, to reap the benefits of compounding.

Consider a savings account currently worth $10,000 earning annual interest of 8 percent. After one year the account is worth $10,800 (1.08 x $10,000). After the second year it's worth $11,664 (1.08 x $10,800). After the third year it's worth $12,597 (1.08 x $11,664) and so on. Savers can realize a considerable return on their initial investment through the "magic" of compounding. The same concept applies, however, to borrowing. To borrow and use $10,000 for three years will cost the borrower $12,597. Interest charges are compounded the same as interest earnings are.

To borrow $10,000 at 8 percent interest and use it for 100 years, as one might do for a flood control project, would cost the borrower $21,997,600. This value is obtained by multiplying 1.08 by itself 100 times and then multiplying this value (2199.76) by $10,000. There are three critical values involved in the determination of the cost of a loan, or correspondingly the cost of a water project. First, there is the principal borrowed (or NED project cost), $10,000 in this case. Second, there is the period of time for which the money is borrowed (or the period of analysis), 100 years in this example. Third, there is the interest which is charged to borrow the money (or the discount rate), 8 percent here. If any one of these factors increases the compounded cost of the loan (or construction cost) would rise.

(Continued)

(Continued)

The future value of $10,000 invested at 8 percent interest compounded annually would yield almost $22 million after 100 years. If that $10,000 is used to build a flood control project, what would the use of that $10,000 cost society over the next 100 years? If the money is used for flood control it costs society the opportunity to earn the $22 million. Thus, the opportunity cost of the $10,000 is $22 million. Higher interest rates can lead to substantially higher costs.

$10,000 now. The general form of the relationship for one year of interest is:

(2) Present value x (1 + interest rate) = Future value

It is just as easy to determine what a sum of money one year from now is worth today. Once again we can compare the two sums and choose the option that yields the most money. It doesn't matter if we compare the value of the two sums of money today or a year from now, as long as both sums of money are expressed at the same point in time.

To express future sums of money in their equivalent present value we do just the opposite of what was done above. Instead of multiplying a present value by (1 + interest rate), we divide the future value by (1 + interest rate). The general form is:

(3) Present value = Future value/(1 + interest rate)

For the given example:

(4) $10,000 = $11,000/(1 + 0.1)

If we are offered at least $10,000 today versus $11,000 in one year, take the money now!

The process of equating present values to future values is called growth. When extended to growth over a number of periods it is most often called **compounding**. The opposite process of equating future values to present values is called discounting. [36]

The common practice in water resources planning is to express all the values that occur over the period of analysis as present values. Thus, future monetary values are discounted so they can be expressed in terms of some agreed upon point in time. The base year is the point in time that is used for water resource projects. So, when we speak of present values it is necessary to speak of present values as of, say, 1995, the base year.

Let's summarize the significance of this and the preceding section. Suppose we have costs expressed at October 1, 1992 price levels as of 1995. What does this mean? First, all costs have been expressed in constant dollars. Those dollars are October, 1992 dollars. This avoids the problems that arise when we are dealing with different
price levels. Expressing these costs as of 1995 conveys to the reader that all future costs have been discounted to 1995. Implicit in this statement is the adjustment of all pre-1995 costs to 1995.[37] All costs are completely equivalent in time and price level and can be directly compared.

Discount Rate

What is the proper interest rate to use when future values are converted to present values and vice versa? The answer is, conceptually, very easy - it is the opportunity cost of capital. Suppose you personally are considering building a levee around your house. To determine your opportunity cost of using your money in this way you use: a) the rate the bank charges you for your loan, or b) the highest return you would earn on your money if you did not use it to build a levee.[38]

When "society" is building the levee what interest rate does it use? Different people have different opportunity costs. Once we move the problem from the individual or firm to society the notion of the proper interest rate to use changes.

Society's choice is different. Society can consume the resources now or invest them in a project that will increase future consumption. The choice society faces is to consume more now or consume more in the future. The rate at which society is willing to trade current consumption for future consumption is called the **social discount rate** and it is based on the time preference of society.

We presume that society, like us individually, prefers to consume now rather than later. To induce society to consume less now and more in the future they must be offered greater consumption opportunities in the future. Given a single grain of wheat, will society eat it now or in the future?
Society may be induced to delay eating the wheat by the prospect of receiving many more grains of wheat in the future if this one is planted now and eaten later.

Consider an analogy. Foreign exchange rates equate the value of a spatially present currency with the value of a spatially distant currency. If the dollar is the currency used in this location it can be equated with any other currency. For example, one dollar was equal to about 125 yen in July 1992. Just as the exchange rate equates spatially distant monies, the interest or discount rate equates temporally distant monies.

The discount rate is used exactly the same as the interest rate in the preceding section. If the discount rate is 10 percent, then society is indifferent between $1 today and $1.10 one year from now. If a project yields more than $1.10 in a year it is worth doing. If it yields less than $1.10 then it's not worth doing. If it yields exactly $1.10 the choice is a coin toss, it doesn't matter.

The problem is there are substantial obstacles to identifying society's time preference, or the rate at which it is willing to trade current consumption for future consumption. The Federal government has settled the matter of what the social discount rate is through a policy decision. The discount rate to be used for water resource projects is based on the cost of government borrowing and it is adjusted on an annual basis.

Average Annual Equivalent Costs

The P&G [39] requires that benefits and costs of water resource projects be expressed as annuities commonly called **average annual equivalent values**. Though it is a more common business practice to use net present value as the decision criteria in capital investment decisions, average annual equivalents have traditionally been used in water resources planning. Decision criteria are discussed in the *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*, but there are no substantive differences between present value and average annual equivalent values. [40]

Water resource project benefits are typically income streams that occur over the life of the project. These income streams, when regular, are conveniently described as average annual values. When the stream of benefits is random and irregular, the methods used to quantify them often result in annual values. [41] In other cases the stream of benefits is known but irregular. Through simple discounting techniques, the present value of all future income streams can be calculated and then converted to an equivalent annual value in much the same way that construction costs are converted to equivalent annual values.

Costs for operating, maintaining, repairing, replacing and rehabilitating a project occur throughout the project life. The only costs of interest are those that occur during the period of analysis. Routine operating and maintenance costs are usually expressed as annual values that require no further equivalence adjustments. Repair, replacement and rehabilitation costs can occur at irregular intervals throughout the period of analysis. These costs must be converted to their present worth equivalents and amortized as described below.

Costs typically occur in more regular flows of cash than do benefits. Most of the costs are incurred during the construction period. Thus, it is necessary to convert these costs to an annual basis. A single present

value can be converted to an average annual equivalent through **amortization**.

Given the construction costs, what is the amount of the annual annuity required to pay off these costs plus the interest on these costs? [42] We can think of this annual value as an annuity, or uniform annual cost spread over the 100 year life of the project that is equivalent to its initial cost, i.e, construction cost plus interest. When the cost of a project has been spread over its life in this fashion it is said to be amortized. The **amortization factor** [43] is also known as the **capital recovery factor**.

When a bank lends us money to buy a house, the bank must recover the loan's principal plus interest. In a similar fashion, recovery of the initial amount expended on a project consists of two components: (1) an annual interest charge on the principal amount, and (2) an annual amount deposited each year that will accumulate to the principal amount at the end of the period.[44] Thus, whether we think of annual costs as an attempt to evenly spread project costs across the period of analysis, or we see them as a two component recovery of the costs of a project is a matter of intuitive convenience. Thus, NED project costs of $50 million at a discount rate of 8.5 percent over 100 years are equivalent to $4.3 million annually. Once all costs and benefits have been reduced to average annual equivalent values with a common price level and base year, it is a simple matter to calculate the benefit cost ratio and to estimate net benefits.

Summary

In water resource planning studies most of the issues that arise as a result of the time value of money have been resolved through policy decisions. All monetary values are expressed at a single price level and are compounded or discounted to the base year. The discount rate is determined annually and is usually published in an Economics Guidance Memorandum. All NED benefits and costs are expressed as average annual equivalent values for the benefit-cost analysis.

SALVAGE VALUE (2.12.4(C))

The period of analysis is generally shorter in duration than the project life. When this happens, a project with the capacity to produce project outputs, hence value, still exists. The remaining value of this asset is to be accounted for in the benefit-cost analysis.

The P&G specify a special case in which the value of remaining assets may be used to offset or reduce NED costs. If land, equipment, and facilities in place at the end of the period of analysis have value for nonproject uses, their salvage value is to be included in the benefit-cost analysis as a cost offset. Significant salvage values of replaceable items such as generators and cranes will normally be reflected as lower replacement costs. The P&G in no way restrict including the remaining value of an asset in the benefit-cost analysis. When the remaining value of an asset is nonproject related the adjustment is to NED costs. When the remaining value is project related the adjustment is made to NED benefits.

EVALUATION PROCEDURE: IMPLEMENTATION OUTLAYS (2.12.5)

Implementation outlays [45] are the explicit costs of implementing a project. Outlays refers to the direct expenditure of money. **Other direct costs**, discussed in a following section, are by contrast implicit costs. Implementation outlays are defined in the P&G to include all the costs to construct, operate and maintain a project. As the planning process and language continue to evolve, it is necessary to remain flexible in interpreting what constitutes an implementation outlay. For example, as life cycle costing and value engineering become more ingrained in the planning process it is logical to expand the definition of implementation outlays contained in the original P&G to include such items as repair, replacement and rehabilitation costs. Figure 15 summarizes the major components of implementation outlays identified in the P&G. Each component is discussed below.

- Postauthorization planning & design costs
  - investigations
  - field surveys
  - planning
  - design
- Construction costs
  - costs of installing projects
- Construction contingency costs
  - allowance for unforeseen conditions
- Operation, maintenance, and replacement costs
  - OMRR&R

Figure 15: Implementation Outlays

POSTAUTHORIZATION PLANNING AND DESIGN COSTS (2.12.5(A))

> "The costs are the direct cost for investigations, field surveys, planning, design, and preparation of specifications and construction drawings for structural and nonstructural project measures." P&G p.97.

These costs would be incurred during what is now called the planning, engineering and design (PED) stage of a project. From an economic perspective all direct costs of planning, engineering and design of a project that remain at the time the economic efficiency of a project is investigated, i.e., when the benefit cost analysis is done[46] are costs of the project. Any study cost that has yet to be incurred and that can be reasonably anticipated, should be part of the cost of implementing a project. Thus, after the reconnaissance study the cost of the feasibility study and subsequent study costs would be considered part of the project cost. As these once anticipated costs are actually incurred they become sunk costs and no longer should be included as project costs. After the feasibility study is completed, feasibility study costs are no longer part of project costs.

Corps practice deviates from this approach as a matter of policy in defining NED costs. The P&G clearly state that onlypost authorization study costs are to be considered part of the project cost. Reconnaissance and feasibility study costs are excluded from project costs. Postauthorization planning and design costs are frequently estimated as a percentage of the construction cost.

CONSTRUCTION COSTS (2.12.5(B))

> "These costs are the direct costs of installing project measures." P&G p. 97.

Construction costs include the market price of purchased materials, including the costs of their transport; equipment rental or purchase; construction wages or salaries including all fringe benefits; and contractors' management, supervision, overhead, and profit.[47] If project construction results in direct or indirect impacts on other resources, any cost of addressing those impacts will be considered part of the construction costs. For example, if physically mitigating the effects of flooding induced in non-project areas results in an explicit cost these costs are considered a construction cost.

CONSTRUCTION CONTINGENCY COSTS (2.12.5(C))

> "These are project costs normally added to reflect the effects of unforeseen conditions on estimates of construction costs." P&G p. 97.

New policies such as the 1986 WRDA Section 902 limits on cost overruns and new analytical techniques such as risk analysis have changed the way in which contingency costs are approached. Regardless of the manner in which these costs are approached, they remain legitimate NED costs. The M-CACES process allows the analyst to make specific contingency allowances for line items in the cost estimate. Though the option remains to make a single gross allowance for contingency costs the ability to use disaggregated estimates can improve the quality of the cost estimate.

ADMINISTRATIVE SERVICES COSTS (2.12.5(D))

> "These are the costs associated with the installation of project measures, including the cost of contract administration; permits needed to install the project measures; relocation assistance advisory services; administrative functions connected with relocation payments; review of engineering plans prepared by others; government representatives; and necessary inspection service during construction to ensure that project measures are installed in accordance with the plans and specifications." P&G p.98.

Administrative services costs are not installation costs. They are the unavoidable costs associated with installation and they can be significant in magnitude. In the past, these costs of supervising and administering the installation of a project were includedamong cost estimates under the entry "Supervision and Administration (S&A)". These costs have

frequently been estimated as a percentage of construction costs.

FISH AND WILDLIFE HABITAT MITIGATION COSTS (2.12.5(E))

> "These are the costs of mitigating losses of fish and wildlife habitat caused by project construction, operation, maintenance, and replacement." P&G p.98.

This cost category should now be expanded to include the costs of **protecting, restoring** and **enhancing** fish and wildlife habitat as well as the costs of mitigating environmental losses. The costs of **environmental resources planning**, the collective name given to protection, restoration, enhancement, and mitigation measures, are as all inclusive as are the costs of any project. Mitigation/environmental resource costs consist of all the same cost elements, e.g., construction and contingency, as installation costs in general and are NED project costs.

RELOCATION COSTS (2.12.5(E))

> "These are project costs associated with (i) the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Pub. L. 91-646); and (ii) the relocation of highways, railroads, and utility lines." P&G p. 98.

Relocation cost is a term called upon to serve two distinctly different purposes. First, and most frequently, it refers to the relocation of highways, railroads, and utility lines. In this usage the costs are based on replacement in-kind. Betterments or upgrades are not part of NED implementation outlays.

The second usage of the term "relocation cost" refers to the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646). The costs of relocating individuals or businesses displaced as a result of a project are also called relocation costs. The NED costs of relocation, in this sense, are also based on replacement in-kind. The costs of any betterment in housing is not considered to be a project-related NED cost.

HISTORICAL AND ARCHAEOLOGICAL SALVAGE OPERATIONS COSTS (2.12.5(F))

> "These are project costs associated with salvaging artifacts that have historical or archaeological values as prescribed by the Preservation of Historic and Archaeological Data Act (Pub. L. 93-291)." P&G p. 98.

The costs of salvaging and documenting resources of historical, archaeological or cultural significance are part of NED implementation costs.

LAND, WATER, AND MINERAL RIGHTS COSTS (2.12.5(G))

> "These costs include all costs of acquiring the land, water, and mineral rights required for installing, operating, maintaining, and replacing project measures." P&G p. 98.

The use of land resources for a project might require the acquisition of related land, water or mineral rights associated with the land. Likewise, land, water and mineral rights might have to be acquired for reasons unrelated to land acquisition. In either case, the costs of acquiring these rights are part of NED implementation costs whether the land associated with the rights changes ownership or not. When private rights are acquired there will be explicit costs.

The P&G go on to point out that when land, water or mineral rights are owned by a government entity that has committed them, more or less in perpetuity, to a specific use, the NED cost will be based on the value of the resources in their dedicated usage. Thus, land devoted to a park use would be valued according to the value of the recreation it produced. Mineral rights used to extract oil or natural gas from the ground would be valued according to the value of the oil or natural gas.

The costs of acquiring rights from government entities will most likely be implicit costs. These costs are not true implementation outlays because there is no expenditure of funds. They would fit more neatly under the heading of other direct costs. Whether the cost has been described in the most appropriate part of the P&G is of less significance than recognition of the fact that costs of such resources are to be included among the NED costs.

OPERATION, MAINTENANCE, AND REPLACEMENT COSTS (2.12.5(H))

> "These costs represent the current value of materials, equipment, services, and facilities needed to operate the project and make repairs and replacements necessary to maintain project measures in sound operating condition during the period of analysis." P&G p. 99.

Operation, maintenance and replacement costs are generally considered to be straightforward in nature. In light of the current emphasis on life cycle costs and value engineering it is worth noting that this category of NED costs known by the acronym OMRR&R should now be considered to include repair and rehabilitation as well.

EVALUATION PROCEDURE: ASSOCIATED COSTS (2.12.6)

> "Associated costs are the costs of measures needed over and above project measures to achieve the benefits claimed during the period of analysis." P&G p.99.

Water resource projects have value because they produce valuable outputs. Some

of those outputs are final goods. Others are intermediate goods. Intermediate goods are used as inputs in the production of final goods or services. The outputs of many Corps projects are intermediate goods, or inputs to a larger production process.

In order to move project outputs to the final consumer or to combine them with other inputs to produce final consumer goods it may be necessary to incur costs in addition to the basic project costs. These are the costs associated with the use and enjoyment of the project's outputs and are called **associated costs.** [48] Associated costs may be borne directly by the non-Federal partner or they may be borne by the private sector.

Associated costs are frequently overlooked when they do not have to be paid by either the Federal government or the non-Federal partner. When private industry and individuals must incur some cost to be able to consume or make use of project outputs, these are NED costs.

The costs of a hydropower project to the Federal government and its non-Federal partner include the costs of the dam and generating equipment. The energy produced cannot be used until transmission lines and individual connections are also provided. These latter costs, born by the private sector, are associated costs that should be included in the economic analysis of the project.

Navigation projects provide many examples of associated costs. A deep draft channel is cost shared by the Corps and its partner. The output of this project is not realized until access channels connecting private users with the main channel are dredged; berths are constructed or deepened; rail spurs built, etc. The costs associated with using project outputs can be substantial.

Associated project costs can, at times, be implicitly accounted for in the manner in which benefits are calculated. This is particularly true when the estimation of benefits is based in some manner on the reduction of costs. For a detailed example of such a case see page 43 of the *National Economic Development Procedures Manual -Overview Manual for Conducting National Economic Development Analysis*.

EVALUATION PROCEDURE: OTHER DIRECT COSTS (2.12.7)

> "These are the costs of resources directly required for a project or plan, but for which no implementation outlays are made." P&G p. 99.

Other direct costs as defined in the P&G are synonymous with what have been called implicit or non-monetary costs in this manual. These costs are direct in that they are incurred as a direct result of project implementation. There are no expenditures associated with these costs, only resource use. Figure 16 summarizes the three types of other direct costs that are part of NED project costs.

The first type of other direct cost identified in the P&G is the use of resources for project implementation for which money is not expended. Land or other resources donated for the project are examples. Resources are used, implying an opportunity cost, but there is no explicit money cost

- Implicit costs of displaced resources
- Uncompensated NED losses
- Negative externalities

Figure 16:
Other Direct Costs

associated with the resource use. These are still NED project cost.

Divergences between money costs and economic costs are commonly cited examples of other direct costs. Examples of this divergence is taken up again in the chapter that follows. These implicit costs should be quantified in monetary terms whenever possible. When it is not feasible to quantify these costs monetarily they should be quantified in other terms and described as completely as possible.

Uncompensated NED losses are a second category of other direct costs. NED losses result when economic output is diminished by the installation, operation, maintenance, or replacement of a project. These costs are also implicit costs. They differ from the first category in that they need not be associated with project construction only. Lost output that can be attributed to project operation at any point in time or space are also NED project costs.

An example of an uncompensated project loss would be the loss of fishing and canoeing opportunities downstream of a reservoir as a result of releases of water. When water is released from a dam, fishermen and boaters may lose access to the river downstream of the dam. This represents an NED loss of recreation user days. No one is compensated for these lost opportunities, yet they are real economic costs of the project.

The third category of other direct costs identified in the P&G are what we called negative externalities in the last chapter. Many of these externalities will be implicit costs. Some of them, however, become explicit costs for the affected third parties. For example, induced flood damages are an NED project cost. From the perspective of the Federal government and its partner, these are implicit costs of the project that neither of them will have to pay. Ultimately, however, when the damage occurs and recovery from the damages is necessary, someone is going to have to make an explicit payment for the relief. In this sense, some of the other direct costs may become explicit costs at some point in time. Externalities are taken up again in the following chapter.

EVALUATION PROCEDURE: PROBLEMS IN APPLICATION (2.12.8)

One of the most common problems encountered in project evaluation is that analysts do not consider the full range of potential NED costs. Too often planners confine their consideration of costs too narrowly to the immediate vicinity of the project. Economic impacts, particularly negative externalities, may extend far beyond the immediate vicinity of the project itself. Likewise, costs can accrue over a very long time period. The analyst has an obligation to

consider the full spatial and temporal extent of NED costs. Significance and practicality are the criteria to use to determine how far you have to go to identify and quantify all the potential NED costs.

Care must be taken to avoid counting a cost more than once. This is particularly true when a project requires acquisition of real property or changes in the use of assets. The value of real property (discussed in Chapter 5) is generally based on the accumulated present worth of a future stream of income. It is easy for an inexperienced analyst to convince himself that the NED cost of a factory is the cost of the land, the building and the net income lost from the foregone production; when, in fact, the value of the land and building is the accumulated present worth of that lost future income stream. To include both these losses would be double counting costs.

The analyst is also cautioned to be aware of large fluctuations in prices in short periods of time. Market prices can be subject to short term and long term perturbations that may be significant to project formulation. Costs should reflect prices current at the time a purchase is made.

EVALUATION PROCEDURE: DATA SOURCES (2.12.9)

Throughout the discussion of NED costs the P&G suggests that costs be based on the **current market prices of good and services**. Some potential sources of market price information include comparable sales, government publications and business reports.

REPORT AND DISPLAY PROCEDURES (2.12.10)

The P&G suggest that the NED costs identified in the preceding sections be identified as line items in the NED account. Project costs are generally summarized in sufficient detail throughout the report to obviate the need for an extended discussion of how to report and display costs, NED or otherwise. Harkening back to the opening message of this report, however, it is important to bear in mind the dual role that project costs play in Corps analyses. NED project costs and project costs must be reported and displayed as two distinctly different, albeit closely related, cost estimates.

SUMMARY AND LOOK FORWARD

This chapter has presented and discussed the NED terminology contained in the P&G. Familiarity with the terminology is only the beginning of understanding NED costs. In the following chapter we look at some of the NED cost issues that go beyond simple terminology.

Chapter 5: SELECTED APPLICATIONS

CHAPTER OVERVIEW

Like most things in life, NED cost analysis is easy once you know how. It's the knowing how that can make analysis so difficult because each Corps project is unique. In this chapter we look at selected categories of issues where unique NED cost analysis problems frequently arise.

The chapter begins by considering what is probably the most common class of NED problems, distinguishing economic and financial costs. Interest during construction, the second topic covered, has always been troublesome because analysts frequently misunderstand what it represents. Local interests are always perplexed to know that NED project costs include interest that no one has to pay. Issues relating to the value of real property follow. This includes the cost of real estate, another frequently occurring problem area. Some issues encountered in calculating average annual costs are also found in this chapter. The chapter concludes with a brief discussion of externalities.

ECONOMIC VERSUS FINANCIAL COSTS

In this manual we have not used the term **financial cost** in order to avoid any confusion with the financial analysis that is conducted as part of every feasibility study. In its place we have used the term money cost. Historically, however, the costs of a recommended plan have been classified as either economic costs or financial costs. Economic costs were used in the benefit cost analysis, financial costs were not.

Financial cost is defined in the Digest of Water Resources Policies and Authorities as follows:

> "Financial costs are any money outlays or accounting transactions or entries whether or not they are payments for resources."

Financial costs should be understood to be synonymous with money costs and accounting costs. Economic costs are opportunity costs. The focus of this section is to determine which costs are the NED costs if and when financial and economic costs are not equal.

Water resource projects present all sorts of situations where it's clear there are costs. The nature of those costs, however, can be very perplexing. Critical to understanding that distinction are the answers to a few simple questions. First, was money exchanged? If so, there was definitely a financial cost[49]. Second, did the choice cost society anything? If it did, there was an economic cost. Third, does the money exchanged equal the cost to society? If yes, the economic and financial costs are the same. Figure 17 summarizes the possible relationships among financial and economic costs. One or more situations presenting each of these circumstances could arise in a single water resource project.

1. Economic Costs and Financial Costs

   a. Economic Costs = Financial Costs
   b. Economic Costs > Financial Costs
   c. Economic Costs < Financial Costs

2. Economic Costs and No Financial Costs
3. No Economic Costs and Financial Costs
4. No Economic Costs and No Financial Costs

Figure 17: Potential Relationships Between Economic & Financial Costs

If there are both financial and economic costs they can be related in any one of three ways. Financial costs may exceed economic costs; they may be equal; or, economic costs may exceed financial costs. It's possible there is a financial cost but no economic cost; or, conversely, an economic cost with no financial cost. Finally, there may be neither an economic nor financial cost. Economic costs are NED costs. Financial costs are irrelevant to the NED analysis.

The economist's job in identifying project costs is to look for market failures; i.e., situations where actual conditions diverge significantly from the perfectly competitive ideal that yields a pareto optimum. Monopoly situations will produce financial costs in excess of economic costs. Unemployed or underemployed resources may have economic costs less than their financial costs. Public goods may be undervalued. Goods with significant positive externalities may have financial costs below their economic costs. Goods with significant negative externalities may have economic costs in excess of their financial costs. Economic theory will always be the basis for a divergence in financial and economic costs. Policy will, however, often be the basis for resolving differences between economic and financial costs as seen in the following sidebar.

TRANSACTIONS WITH ECONOMIC AND FINANCIAL COSTS

One could argue that all transactions have economic and financial costs. At the extremes, one or the other of these costs are simply zero. In this section we break these extreme situations out as separate cases.

Economic Cost Equals Financial Cost

The vast majority of costs encountered in a water resource project will be both economic and financial costs. All the basic inputs to a project like land,

Monopoly and Taxes

Suppose a water resource project uses an input that was produced by a monopoly. The monopolist's price exceeds marginal cost. Is the cost of the input its market price, which measures its value to consumers (in this case, the government); or is it its marginal cost, which measures its value in production?

The answer depends on the impact of purchasing the inputs on the market. Does the project use this input at the expense of producers or consumers? If government purchase of an input causes input to increase by a like amount, the social opportunity cost of the input is the value of the resources used in production, i.e., the marginal cost. If no additional input would be produced to replace what was used by the project, then government use of the input takes it away from the consumer. The value of this input is measured by its purchase price. Hence, the market price should be used. If some portion of the project input would be replaced and some not, then a combination of marginal cost and price is used.

Paragraph 1.4.9(c) of the P&G directs planners to use projections:

> "..based on a full employment economy. In this context, a full employment economy establishes a rationale for general use of market prices in estimating economic benefits and costs.."

The effect of this policy is to assume that the production of input cannot be increased because the economy is operating at full employment. Thus, consumption comes at

(Continued)

Monopoly and Taxes (Continued)

the expense of other consumers and the market price is the proper price to use when valuing goods and services produced by a monopolist. NED costs are, consequently, the market prices in such cases.

Taxes can distort prices in a manner similar to that described above. If an input is subject to a sales tax, the price received by the producer is not the price paid by the consumer, some part of the price goes to the taxing government. So, at which price is the input to be valued? If production would expand as a result of project demand, use the producers supply price, i.e., marginal cost. If production stays constant, use the purchaser's demand price. Again, the P&G's full employment assumption appears to suggest that the market price is applicable.

concrete, steel, labor, equipment, etc. require the exchange of money while they cost society the opportunity to use these scarce resources in an alternative way. In virtually all of these cases the money exchanged for the resource will be a good measure of the resource's economic value. When this is so, economic and financial costs are equal, as they are for the vast majority of resources used in project construction and operation. In a certain number of instances, however, economic and financial costs will not be identical.

In some cases where, because of market failure, market price deviates from marginal cost it is the policy in practice to use the market price. This is done when it is theoretically difficult or practically impossible to quantify the differences between financial and economic costs. In other cases the financial and economic costs

may be theoretically equal but they will differ from NED costs due to policy decisions. The financial and economic costs of a betterment are theoretically equal but the betterment costs are not included among NED costs. The financial and economic costs of relocating people under the Uniform Relocation Assistance Act are identical. Certain of these costs are not included among the NED costs, however.

As if distinguishing financial costs from economic costs were not difficult enough, the analyst must also be aware of circumstances where, for policy reasons, NED costs may differ from the other two.

Economic Cost Less Than Financial Cost

The financial cost of a transaction may exceed its economic cost. In order for the use of a resource to have an economic cost it must cost society something, i.e., the resource has to have an alternative use. Unemployed or underemployed resources often cost society less than their price. Labor cost is frequently cited as an example of a financial cost that exceeds its economic cost. Unemployed or underemployed workers may be paid a wage (financial cost) that exceeds the true opportunity cost of their time (economic cost).

An unemployed worker has nothing but leisure time, so much so that he may place a value on his leisure time that is substantially below the wages paid for project construction. Non-union employees who normally work for a wage lower than the union rate may receive a union wage on a Federal project. In both these cases there are economic and financial costs. The financial costs or wages, however, exceed the economic costs. Economic theory would direct the analyst to use the economic cost rather than the wage rate in the benefit cost analysis. Corps policy diverges from economic theory on this point and directs

Riverbank

A more recent example where financial costs exceed economic costs arises in the context of land values. Providing lands, easements and rights of way is the responsibility of the non-Federal partner. If the value of these items do not reach a certain proportion of project costs, like 25 percent for a flood control project, the non-Federal sponsor may be required to make additional cash contributions toward project costs.

Consider the case where the non-Federal partner is providing riverbank land as part of their contribution toward project costs. What is the cost of this resource? If the non-Federal partner must acquire these lands from another interest, money will exchange hands. The owner of the riverbank has a right to the land. When that right is transferred to the government, real property, in the eyes of the law, has changed hands and the owner is entitled to financial compensation, say $1 million. If the partner owns the land and donates it they would receive a credit for $1 million.

Suppose that as a result of the project the riverbank will no longer be accessible to fishermen and hikers. This entails an opportunity cost connected with using the riverbank as part of the project. Further suppose the value of these limited uses have an accumulated present worth of $200,000, far less than the price paid for the land or the credit given. The NED cost of the land used in the benefit cost analysis is $200,000. The $1 million financial cost is used for project implementation considerations.

analysts to use the wage rate for calculating NED costs. The P&G direct that adjustments to reflect the difference between financial and economic costs in the case of the unemployed worker are to be made on the benefit side of the ledger as redevelopment benefits.

Rates charged by railroads may, due to the existence of market power, exceed the economic costs of the resources required to move a commodity. Acquiring a streambed or a riverbank may result in financial costs in excess of economic costs. A giddy land market might result in temporarily inflated property values that exceed the true value of the property.

It's impossible to catalogue or anticipate all the circumstances under which financial costs might exceed economic costs as the following example illustrates. A recent project used borrow at considerable financial cost with relatively little economic cost. The borrow was located beneath some ball fields. The fields were temporarily relocated, the borrow removed and the fields replaced no harm done. The cost of removing and transporting the fill are obvious financial and economic costs that are identical. However, the cost of the actual fill is almost solely a financial cost. The loss of vertical location is assumed to have some value, but because it did not increase any known hazards or exacerbate any access problems the economic costs are assumed to be negligible.

Economic Cost Exceeds Financial Cost

Public goods and goods with substantial positive externalities will be most likely to have economic costs in excess of financial costs. In water resource planning it is not uncommon to encounter situations where there are no financial costs. These special cases are discussed below. Less common are the instances where there are some financial costs.

Some project impacts may cost society more than the exchange of money covers. For example, acquisition of marshlands may impose a financial cost to the project of $3,000 per acre. The true economic value of the land as habitat and an important part of the food web, significant positive externalities, may be estimated to be $100,000. The PCA costs will be based on $3,000 per acre but NED project costs will be based on $100,000 per acre.

Other special or unique resources may also have divergent costs: historical structures, cemeteries, churches, coastal land, land with unique histories, land with unique views or vistas, etc. A temporarily depressed land market might undervalue a property because of short term perturbations in the market's assessment of a property's future income potential. Land values may be severely depressed in the immediate aftermath of a flood as potential buyers and sellers overestimate the risk of flooding.

Actions taken by individuals can also result in divergences in costs that make it impossible to anticipate or catalogue all the circumstances where economic costs exceed financial costs. For example, consider the actions of a foresighted non-Federal partner who stockpiled "rip-rap quality" rock during excavation for a highway project. Now suppose rip-rap is needed for a navigation project. Purchasing and hauling the rip-rap would cost $1.5 million but the non-Federal sponsor can move the stockpiled rock at a

cost of $100,000. The financial cost is $100,000 but the economic cost is the value the rock could fetch in the current market or $1.5 million.

TRANSACTIONS WITH FINANCIAL COST BUT NO ECONOMIC COST

Economic costs are concerned with the use of real resources rather than financial resources. If real resource uses are not affected, there is no economic cost even when money changes hands. The streambed sidebar provides an example. The solitary act of exchanging ownership of a resource has no effect on real resources. Real property transactions, discussed in a subsequent section, frequently involve the buying and selling of rights of way and easements that have no effect on a resource's use. These transactions will have financial costs but in many cases there will be no economic cost.

Purchasing a construction easement to drive construction equipment over private land may have a cost. If no damage is done to the land, however, there may be no economic cost.

Streambed

Consider another current problem with land values. Suppose a project requires acquisition, at a cost of $1 million, of land that is and will remain streambed. If the land always was streambed and will always remain streambed whether the project is built or not, then what has the project cost society? Nothing, there is no change in the use of real resources. There is no economic cost. No opportunities have been lost. In this case the project costs will include the fair market value of the land, $1 million, among the implementation costs. The NED project cost for this land is $0.

Flow easements might be purchased to allow periodic flooding of a parcel of land. If the flooding does not change the land's use or productivity in any way, there is no economic cost. A non-Federal partner may be required to purchase the right to use a beach for public access, despite the fact that the privately owned beach has always been used in this way and predictably always will be.

TRANSACTIONS WITH ECONOMIC COST BUT NO FINANCIAL COST

Projects cost society something without an accompanying exchange of money more often than money changes hands with no economic cost. Construction causes noise that disrupts hunting. Sediment run-off fouls fishing. Aesthetic values may be lost forever. Though examples are plentiful many of them are trivial in all but the most extreme circumstance. The economist's job is to identify and analyze those that are potentially significant for plan formulation.

Interest during construction is an economic cost adjustment that can total millions of dollars that are part of the NED project costs but are not financial costs. Induced flood damages is an economic cost that is part of NED project cost but are not normally accompanied by an exchange of money.

It is common practice not to pay for an easement when improving a channel takes some small part of a property if the improvement provides incidental flood protection to an adjacent property owner. It

is considered a fair trade. Though there is no financial cost, there is an economic cost. Donated land or other resources come at no financial cost but their use in the project incurs an economic cost.

Some environmental losses cannot be mitigated and so they entail no financial costs. These losses are economic costs whether they can be estimated or not. When economic costs cannot be quantified in money terms they should be quantified as completely as possible and described in the NED account, though they will not be included in the benefit-cost ratio.

As usual, there are examples that are too unusual to anticipate. For example, a dredging company offered to dredge a channel for the gravel they could salvage from the river bottom at no cost to anyone. Project sponsors found this an attractive option. There is a financial cost for this activity and it does equal the economic cost of the activity. However, from the accounting standpoint of the project there would be no financial cost. The economic costs, from the perspective of the Federal project, would greatly exceed the financial costs. Economic costs are virtually always[50] included among the NED project costs even when there is no concomitant financial cost for the project.

TRANSACTIONS WITH NEITHER ECONOMIC NOR FINANCIAL COSTS

If no money changes hands and no costs are imposed on society, then the resource use entails neither an economic nor a financial cost. As you might expect, however, such situations rarely arise. When they do, they tend to be trivial as the following example illustrates. During project construction, workers and heavy equipment consume oxygen. This costs society a real resource that is not scarce and it does so without imposing a cost on society or an exchange of money. Transactions such as these are irrelevant to NED costs and to implementation decisions.

INTEREST DURING CONSTRUCTION

Interest during construction calculated on a $100 million project can, depending on the construction schedule, add tens of millions of dollars to the NED project costs. Non-Federal partners, among others, have expressed concern, dismay, and confusion about the need to include such a cost in the project evaluation; especially when they learn no one actually pays these costs. We begin this chapter with two major points. First, interest during construction is not a financial cost. No one will ever be required to pay a penny of this cost. Second, what the Corps calls interest during construction is actually an equivalent value adjustment of pre-base year costs. Because the adjustment is made to economic costs interest during construction is an economic cost.

Nothing can be added to the first point. To better understand the second point we consider the equivalence of money values and society's time preference. An example describing a situation, outside the Corps' program, where interest during construction could be a financial cost is offered. The section concludes by developing the idea of the equivalence adjustment more fully. A detailed discussion of interest during construction can be found in *National Economic Development Procedures Manual-*

Urban Flood Damages, IWR Report 88-R-2. Additional guidance on the subject can be found in chapter 6 of ER 1105-2-100.

EQUIVALENCE OF MONEY VALUES

The distribution of costs and benefits associated with a project over the planning horizon is sometimes called the **cash flow profile** of the project. A cash flow profile shows the magnitude and timing of the occurrence of money sums, i.e., benefits and costs, over the construction period and period of analysis. Construction costs typically occur prior to the base year. Additional costs for operation and maintenance, repair, replacements, and rehabilitation may occur sporadically over the period of analysis. Benefits, on the other hand, typically occur throughout the period of analysis.

Sums of money that occur at different points in time have different values and cannot be directly compared to one another. Consider Figure 18. The first year of the period of analysis is called the base year[51]. Notice, in the example, that construction takes place prior to the base year and benefits accrue after it. In fact, benefits often accrue prior to the base year.

Project benefits and costs must be given at the same price level and compared at the same point in time. They could be compared 17 years after the project is completed, 4 years before the project is completed, or at the time the project is completed. As a matter of convention, the Corps uses time (t) = 0, the base year, as the year in which all money values are to be expressed. The choice of the year in which dollar values are compared has no effect on the economic feasibility of the project under consideration.

As Figure 19 shows, if dollar values are to be compared at the point t = 0, then dollar values that accrue after t = 0 must be moved backward in time. Dollar values that accrue before t = 0 must be moved forward in time. Money cannot be shifted through time without changing its value. As discussed in Chapter 4, $1 in the future is not worth as much as $1 today. Likewise, $1 today will be worth more than that in the future. Hence, when we move

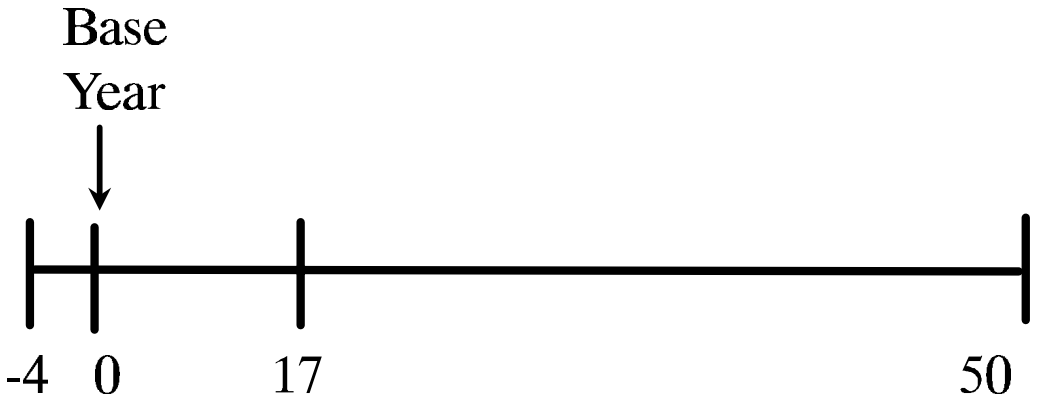


Figure 18: Base Year

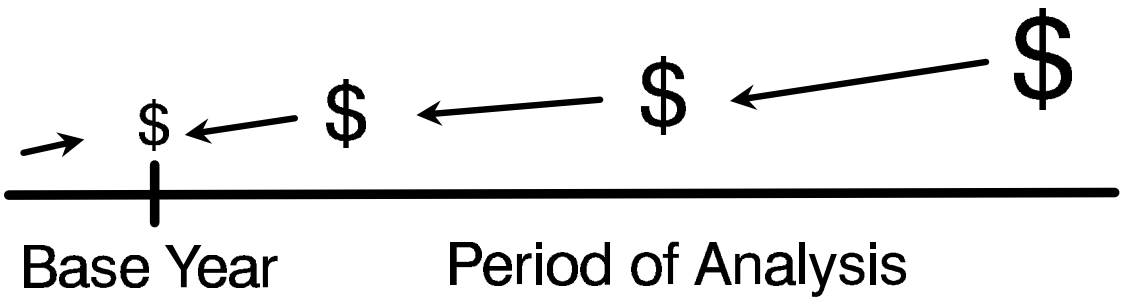


Figure 19: Time Value of Money

a dollar valueforward in time we compound or grow it. As $1 is moved from t = -4 to t = 0 its value increases. When we move a dollar value backward in time we discount it. As $1 moves from t = 17 to t = 0, its value decreases.[52]

Two or more separate sums of money can be compared only if their value is expressed at the same point in time. They have to be converted to an equivalent time basis. The factors that affect the equivalence of two or more sums of money are: 1) the amount of money; 2) the time at which the money accrues; and, 3) the discount rate.

The interest during construction calculation makes costs incurred before the base year equivalent in time value to other benefits and costs. Because construction costs must be moved forward in time they are made bigger. In Corps studies all dollar values are compared as of the base year.

TIME PREFERENCE

The simple fact that dollars at different points in time have different values is often called "the time value of money." There are three reasons why money is said to have time value. First, money has a potential earning power. If we invest a dollar now it can earn some return for us. In this sense, earning power can be considered as the cost of using money (a rental fee).

Second, money has time value because the purchasing power of money changes over time. As a result of inflation, $1 today can purchase more goods than $1 will buy in the future. The P&G directs planners to use real prices, effectively saying, "assume no change in price levels." Hence, changes in purchasing power are irrelevant to the water resources planning process as conducted by the Corps.

A third reason for the time value of money is that a user, in this case the user is society, may have a different utility of consumption at different points in time. Society may get more or less satisfaction from using different dollar amounts at different times, depending on society's rate of time preference. For example, suppose society's rate of time preference is 10 percent per year. In this case society would be indifferent between a choice of consuming $100 worth of

goods now or consuming $100(1 + .1) or $110 worth at the end of the year.

Interest During Construction Can Be A Financial Cost

There is frequently considerable confusion about interest during construction. Is it a financial/money cost? Is it an economic cost? Is it both? Is it neither? In Corps analyses interest during construction is an economic cost and not a financial cost. In other circumstances where construction is financed through borrowing, interest during construction may be a financial cost.

Suppose you are building a home. If you go to a bank to get a mortgage, they may tell you that you cannot get a mortgage until there is a home. But you may not be able to build the home without a loan to purchase materials and labor. In a case like this, you may have to get a construction loan first. With a construction loan you get the money you need to build the house. The term of the loan usually lasts as long as it takes to build the house (or to build and sell it if you are a developer). You would, of course, be required to pay interest on the construction loan. Once the house is built, you would obtain a loan which would be used to pay off the construction loan.

In this scenario you are actually paying interest during construction in addition to interest on the mortgage. Interest during construction is a financial cost here. Corps projects are not financed in this manner. Generally, neither the Corps nor its non-Federal partner make construction loans that require payment of interest prior to the project base year. If there are no loans during the construction period there is no obligation for anyone to pay interest during construction and it is not a money cost of the project.

Though the Corps does not require an actual payment of interest during construction, that is not the only way of doing business. Project sponsors that must finance projects through borrowed funds would be expected to begin paying interest as soon as the loan is made, regardless of the project base year. These costs reflect the earning power dimension of the time value of money, also known as the opportunity cost of financial capital. If actual interest payments are required then they will be included among NED project costs and the cost estimates used for project implementation.

IDC As A Pre-Base Year Cost Adjustment

Interest during construction is included among the economic costs that comprise NED project costs. This is because of society's time preference or the differing utility of consumption now versus consumption in the future. Normally, an economic cost is the value of the resource(s) in its best alternative use, i.e., the opportunity cost of the resource. Interest during construction does not entail the use of any resources in addition to those that have already been identified and accounted for among project costs. The cost of a cubic yard of concrete represents the opportunity cost of the concrete. Interest during construction charges assessed against the concrete do not represent the use or loss of any additional resources. Nonetheless,

Pre-Base Year Benefits

On occasion project benefits may begin to accrue prior to the base year. Completed sections of channel may begin to support greater draft vessels long before the main channel work has been completed. Sections of levee may provide parts of communities with protection soon after a construction project is initiated. Benefits that accrue prior to the base year must be increased as they are moved forward in time to make them equivalent to other base year values. In this regard they are no different than pre-base year costs.

interest during construction is an economic cost.

Perhaps it is most appropriate to consider interest during construction to be an equivalence adjustment, particularly when interest during construction is not a money cost of the project. The real resources used by the project have an opportunity cost. That cost is the price of the construction materials, equipment and labor required to implement the project. If that price is paid before the base year, however, it cannot be considered to be equivalent in time value to future benefits and costs. The pre-base year costs must grow as shown in Figure 19.

Most project costs are incurred before the base year. While it is common to discount, or reduce, dollar values that occur in the future, i.e., after the base year, some analysts are not familiar with the need to "future value" or increase dollar values that occurred in the relative past.[53]

Suppose the base year is 2000. An expenditure of $100 million in 1995 is not the same as an expenditure of $100 million in 2000. One hundred million dollars in 1995 is worth more than $100 million in 2000. To express the 1995 sum in terms that are equivalent to other values in 2000 it must be increased. "Future valuing" or compounding a cost incurred prior to the base year should reflect society's time preference for consumption now versus in the future. For example, if costs are incurred at the start of the year and the interest or discount rate is 10 percent, we would say that society is indifferent between consuming $100 million in resources in 1995 and $161 million in the year 2000. The $61 million difference between the two values though actually an equivalence adjustment has come to be called interest during construction.

The computation is actually done to make costs and benefits equivalent in their time value. **Value adjustment of pre-base year costs** is far more descriptive of the true purpose of the calculation and is less confusing to non-economists. Using this term might minimize some of the confusion that results from the term interest during construction.

THE IDC CALCULATION

Samples of interest during construction calculations can be found in the *National Economic Development Procedures Manual - Urban Flood Damage* and in ER 1105-2-100. The size of the pre-base year cost equivalence adjustment depends on the interest rate, the construction schedule which determines the point in time at which costs occur, and the magnitude of the costs to be adjusted. These first two items are covered adequately in the referenced manual.

Less well understood is which costs should be adjusted. Because the adjustment is popularly known as interest during construction, it is commonly believed that construction costs are used for this adjustment. This is not necessarily so.

Adjusting pre-base year costs is done to make all economic costs equivalent in price and time. The costs that must be made equivalent are the costs included in the benefit-cost analysis, i.e. the NED costs. Construction costs are not always the same as NED costs and it is NED costs that should be adjusted, not the construction costs.

REAL PROPERTY VALUE

REAL PROPERTY

Real property and **real estate** are often used interchangeably though they have quite distinct meanings. Real estate is the land and its improvements. Land is the earth's surface and everything on or under it. Improvements are considered to be "permanently" attached to the land in the way that buildings or land treatments such as landscaping are. The ownership rights of real estate are called real property. This "bundle of rights" includes the right to use, rent, sell, or give away the real estate as well as the right not to exercise any of these rights.

VALUE

Value is one of the fundamental concepts of economics. Value reflects a good's relative scarcity and is frequently determined by the interaction of supply and demand. So says the science of economics. The art of valuing property, as practiced by Realtors, appraisers, the courts and others is greatly influenced by legal and institutional constraints.

Economists look at the value of real property from a theoretical perspective. Appraisers, Realtors and lenders see it quite differently. This, again, stems from the dual uses to which costs are put. Economists are evaluating the social value of the project, appraisers are estimating the costs of implementing the project. There are perhaps more similarities than differences in how the two groups look at value, but the differences can be significant.

THREE MEASURES OF REAL PROPERTY VALUE

Real property values are determined by one of three appraisal methods: 1) **sales comparison approach**; 2) **cost approach**; and, 3) **income capitalization approach**. An economist taking a more theoretical view of these approaches would argue that under ideal conditions each method would yield precisely the same estimate of value. Realtors, working in a much more constrained environment, know the methods could yield different values in practice.

Sales Comparison Approach

The sales comparison approach is closest to the economist's ideal measure of value. In theory, a willing buyer and a willing seller will agree upon a price that most nearly reflects the true value of the property. In reality the market doesn't always operate this way. For example, when parents sell homes to children they do not

exact the same price that two objective and impersonal parties would for the same property. Thus, the price paid for a property may not always be conveying the information we might hope it does. Appraisers investigate the circumstances surrounding the sale to ensure that the sales price is an "arm's length" transaction, representative of a competitive market.

For the sales comparison approach the appraiser gets the prices of several similar properties that have sold recently. To assure that the properties are as comparable as possible the appraiser will adjust the sale prices of the comparable properties for differences in time, economic forces that may have affected the sale, neighborhood, location, site advantage, age, size and quality of building construction. Noting the relevant differences in the properties, the appraiser makes adjustments to the sales price of the comparable property to obtain an estimate of market value of the property being appraised. The process is summarized in Figure 20. Using the sales comparison approach the estimated market value of the subject property is derived. The actual market value is not known until the property is sold.

Cost Approach

With the cost approach, the appraiser estimates the cost of any improvements to the land, such as structures, in terms of the replacement cost new. The appraiser is trying to estimate the cost of duplicating the utility offered by the structure. This is not the same as **reproduction cost** in which an exact replica of the building is produced.

Once the replacement cost new is estimated, the appraiser subtracts any loss in value that has resulted from depreciation of the improvements. Finally, the appraiser adds the estimated value of the site itself. Figure 21 summarizes the basic elements of the cost approach.

From an economist's perspective, the cost approach when used in the imperfect real world, reflects only the supply side of the market. This approach could seriously underestimate the scarcity value of real property by ignoring the buyers' side of the market, i.e. the demand for property. Appraisers usually do not rely solely on this method as their only estimate of value. When the sales comparison or income capitalization

Figure 20: Sales Comparison Approach

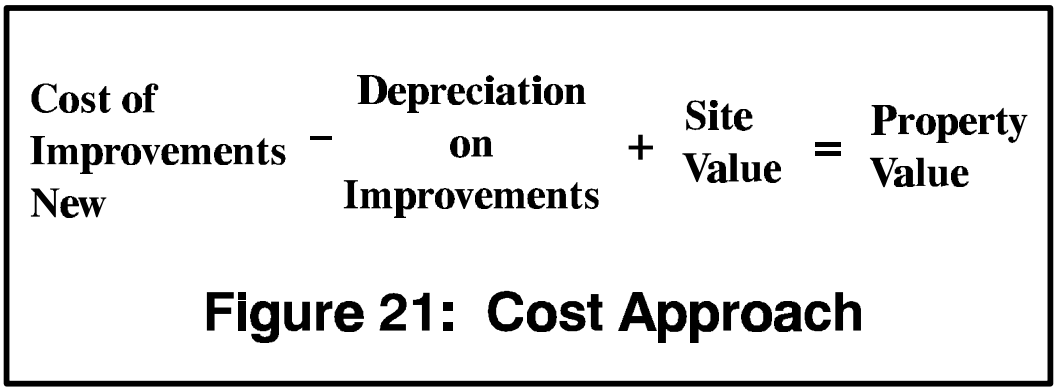


Figure 21: Cost Approach

approach would be difficult to apply, the cost approach may be more applicable. It is frequently used for specialized types of property such as churches, synagogues and municipal properties. The cost approach is not used to determine land values.

Income Capitalization Approach

The value of real property is based on its annual net income in this approach. When a person buys real property, they are essentially buying a stream of income. This is easiest to see when we consider the value of commercial property. **Net operating income** is the key for estimating property values. Figure 22 summarizes the approach by presenting the capitalization formula.

Net operating income is gross operating income (rents plus other income such as vending machines, etc.) less all expenses associated with operating and maintaining the property. This is the income stream that the buyer of the property is purchasing. To determine the accumulated present worth of an income stream that can be owned in perpetuity, you divide the net operating income stream by the appropriate capitalization rate (rate of return), to obtain

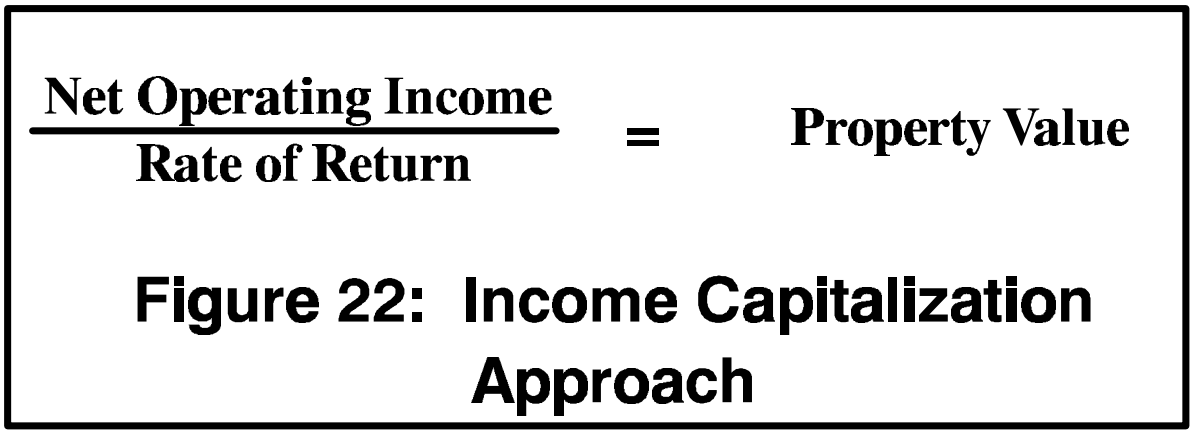


Figure 22: Income Capitalization Approach

the property value. For owner-occupied residential properties **imputed rent** is used in place of gross operating income. An imputed rent is the rent one would receive if the property were rented in the free market. Expenses of maintaining the building must be subtracted to obtain the net revenue from the residential property.

USE OF REAL PROPERTY VALUES IN WATER RESOURCES PLANNING

As with all cost information in water resources planning, there are two specific uses for real property values. Real property values are estimated to determine the money cost of acquiring property. These cost estimates are needed for cost-sharing and project implementation. The economic value of real property, that may deviate from the money costs, is needed to formulate projects and to do economic analyses. Real property values may be used for benefit estimation as well; they figure prominently in the computation of flood control damages and benefits.[54] Planners are well advised to bear in mind that the definition of value can vary with the usage of the value. This can lead to multiple estimates of real property value without any one of them being wrong.

Consider the following example. There are two identical houses side-by-side in the flood plain. One must be acquired to make way for a levee, the other will be protected by the levee. Flood control benefits are based on the replacement cost less depreciation of a structure.[55] This is essentially the cost approach described above. It is used for flood damage estimation because it best captures the value of the resources (e.g., paint and 2 x 4's) that would be damaged in the flood. Suppose this value is estimated to be $60,000.

Appraisers estimating the value of the structure to be acquired and razed may find the current market value of the property to be $50,000. This means we have a house that would cost $60,000 to reproduce at this location and in this condition that can be purchased for $50,000. This is not unusual. To use a $60,000 price for acquisition would overstate project costs by $10,000. To use the $50,000 market value estimate would reduce flood damages by one-sixth[56]. Because the uses of the data are different it is okay to use different values for what amount to identical properties.

Now suppose there is compelling evidence to suggest that recent flooding has seriously depressed the real estate market in the flood prone area. Flood plain occupants will willingly accept $50,000 for their homes, but in time property values will surely rise again. Though it is rarely done because of the pragmatic difficulties encountered in quantifying deviations in long-run and short-run prices, it may be entirely proper to base the economic cost of the house on its long-run value of $75,000. Though this example has focussed on the value of a structure land values are subject to the same issues.

In this simple, albeit contrived example, there are three different estimates of the property's value. Each is clearly appropriate for the use to which it is put[57]; furthermore, it would be incorrect to use any other value.

Confusion can arise when analysts are unaware of one another's differing information needs. In some districts, planners estimate the real value of properties subject to risk of

flooding or loss using the replacement cost less depreciation approach. It could be wrong to use these data or this approach as an estimate of costs for cost-sharing. In other districts, appraisers estimate flood plain structure values. If they use current market values, biased flood damage estimates may result. No matter what property values are needed for or who is responsible for estimating them, it is essential that the use to which the data will be put be considered when deciding which method to use.

Miscommunication is common because of the dichotomous use of cost data. Real estate personnel are concerned almost exclusively with the implementation costs of a project. Appraisers in pursuit of their normal duties have no interest in the issue of whether economic and financial costs are equal or not. Issues like these must be carefully communicated from the outset of the study process.

Economic costs, specifically NED project costs, are required for the benefit-cost analysis. There are many instances where the financial cost of real property exceeds the economic costs. Some of these were described in the earlier discussion about economic and financial costs. Because economists are more concerned with the theory and science of value and Realtors with its legal and institutional constraints, it stands to reason that they will frequently see questions of value differently. This makes it important to identify in advance: the uses for the data and the applicable rules that will guide the ensuing analysis. Early and frequent communication is the solution to this problem.

VALUE OF UNIQUE OR HISTORIC STRUCTURES

There is no simple way to estimate the value of a unique or historic structure. There are no sales that are comparable and the adjustments for differences in properties are too unique to account for with any confidence. How much are the White House, Mount Vernon, the Smithsonian Museum of Natural History worth? Yes, they could be sold but it would be very difficult to appraise them.

Unique properties are rarely rented or used for income producing purposes. This limits use of the income approach. The replacement cost approach can almost always be used to estimate the cost of duplicating a unique building amenities and utility but it fails to capture the scarcity value of a unique resource.

Economic theory provides for the estimation of the value of any resource, no matter how unique. The pragmatic problem is that rarely can the time and expense involved in collecting the necessary data be justified in the context of a water resource study. Perhaps more importantly, some of the data may be unavailable at any price.[58]

It is almost inevitable that the value of a unique property estimated by an appraiser will be very different from its value as estimated by an economist. The former works with appraisal approaches and the conventions of law and the real estate industry, the latter works with theory and the conventions of its science. It is, however, not only inevitable but it is desirable given the different uses for the cost information.

There are two valuation approaches that may be worth considering when presented with the case of a culturally unique resource.

One method that may be very useful for economists' purposes is to use the income approach of estimating the property value. An abbreviated survey may be sufficient to estimate the net income that could be generated at the property if, say, admission were charged or it could be rented to some appropriate user. This approach may not be feasible because of its data requirements or because it is not appropriate for churches, synagogues and certain types of buildings.

Alternatively, the cost approach may be useful. The reproduction cost method is frequently used by appraisers to estimate costs of unique structures for project implementation. In some special cases the cost of replicating the structure may be a more appropriate estimate of the structure's scarcity value than the cost to replace it.[59] Estimating replacement cost with a subjective adjustment to reflect the resource's uniqueness may be the best fall back position for both implementation and formulation purposes. The amount of effort an analyst should expend to estimate the value of the structure depends, of course, on its importance to the formulation and acquisition processes.

AVERAGE ANNUAL COSTS

COMPUTING AVERAGE ANNUAL EQUIVALENT COSTS

NED project costs are incurred over the life of a project. Construction requires large expenditures of money. There may be additional implicit costs of construction. Once the initial project is in place there are routine and reasonably predictable costs of operating and maintaining the project from year-to-year. Repairs that are beyond ordinary project maintenance are another project cost that can be easily anticipated. Parts of the project can be damaged by weather or accidents, other parts simply deteriorate with use. Depending on the nature of the project, there may be periodic costs incurred to replace a component of the project. Another potential project cost is the cost of rehabilitating it at some point during the period of analysis to assure the project performs up to some minimally acceptable standard.

Figure 23 presents a hypothetical distribution of the above described costs over time. Varying magnitudes of costs are spread unevenly over the period of analysis. It is very difficult to summarize the costs of a project when they can occur like this. Average annual equivalent costs provide a convenient and easily understood way to express project costs.

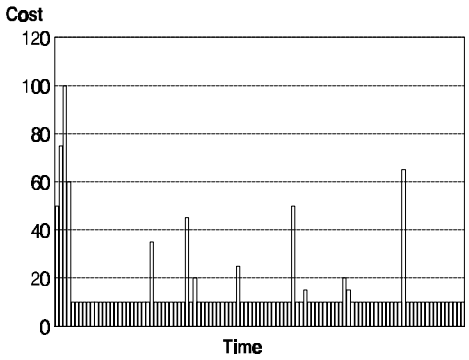


Figure 23: Cost Cash Flow

Average annual equivalent costs, also known as average annual costs, are easily computed once the accumulated present worth is known. The accumulated present worth is a single number that represents the value of all costs, pre-base year and post base year, expressed in terms of their value at the same price level in the base year. Figure 24a shows the cost of Figure 23 expressed as a single accumulated present worth. The accumulated present worth is multiplied by the **capital recovery factor**[60] (CRF) to obtain average annual equivalent costs. Multiplying an accumulated present worth by the CRF shown above yields a uniform value that is intuitively equivalent to an annual payment each year of the project life that will cover all the costs shown in Figure 23. This average annual equivalent value is shown in Figure 24b.

EXTERNALITIES

IMPLICATIONS OF EXTERNALITIES FOR PLAN FORMULATION

The concept underlying externalities is a simple one. A person initiating an action does not necessarily bear all the costs or reap all the benefits himself. When making decisions, people pay attention to the benefits they receive and the costs they bear. Most of the discussion of decision-making found in this manual implicitly assumes that the private or internal costs of water resource projects considered by decision- makers equal their social (internal plus external) costs. Situations exist, however, where costs of producing a water resource project and consuming its outputs are borne by others without their consent.

Economists call costs and benefits that

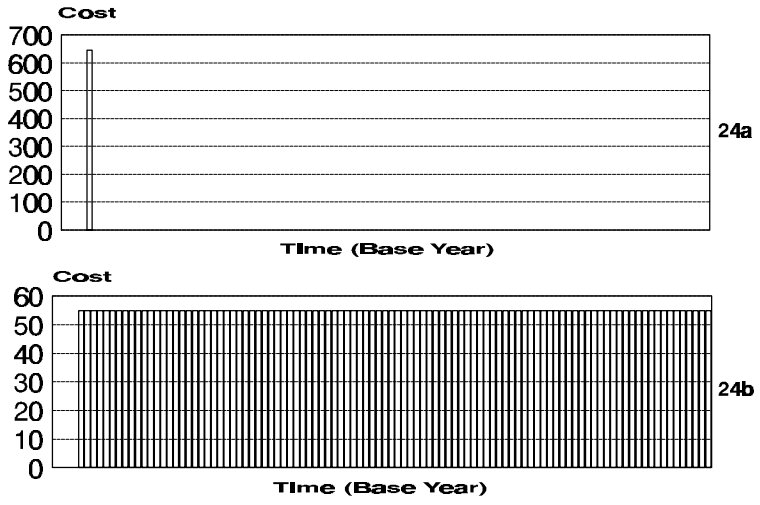


Figure 24: Accumulated Present Worth of Costs

spill over into other people's lives, **externalities**. Detrimental or negative externalities are the costs or damages of a market transaction or decision imposed on someone other than the parties to the transaction, without corresponding compensation being paid by those who generate the externality.[61] Externalities are economic costs that do not normally appear as money costs in an economic analysis.

Figure 25 demonstrates the significance of negative externalities for the planning process. The marginal social benefit curve (MSB) shows the marginal social benefits of a water resource project. The marginal private cost curve (MPC) intersects the MSB curve at $Q._P$ Planners using this information to maximize net benefits would recommend the project that produces output $Q._P$ Now suppose there are external costs in addition to the private costs. Marginal social costs (MSC) are represented by the curve MSC. Taking marginal social costs into account the net benefit maximizing project size is Q_S, considerably smaller than Q_P.

MPC ignores externalities. MSC does not. If externalities are not accounted for[62] plan formulation may be affected. The NED plan may be misidentified, as happened above; or plans that appear to be economically efficient (i.e., MSB > MPC) such as Q_P in Figure 25 may in reality be inefficient (i.e., MSB < MSC), as was seen when marginal social costs were added.

INDUCED FLOODING

Flood control projects that protect one area from flooding may inadvertently increase flooding in another area. This increase in flooding is called **induced flooding**. Sometimes induced flooding is an internal cost of the project, paid for by its sponsors and sometimes it is an external cost borne by residents of the affected communities. The pool of a flood control reservoir might flood properties that have never been flooded before constituting a legal "taking" of the property that the property owner must be compensated

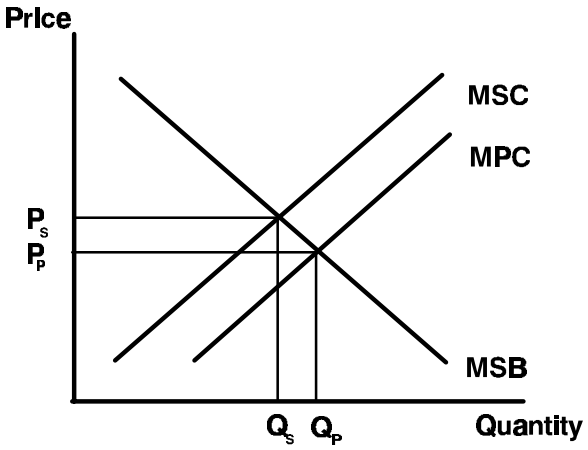


Figure 25: Negative Externalities

for under the Constitution. The legal system has internalized the cost of this spillover effect.

In contrast, a levee project may increase flood depths in nearby communities. A flood that occurs with a given frequency may produce greater flood depths with a project than would occur without a project. The magnitude of these induced damages can normally be estimated by calculating and comparing expected annual damages (EAD) without the project and with the project in the communities subjected to induced flooding. Table 5 provides an example.

Total EAD without a project are $245,000; with a project they are $273,000. The project causes unintentional damages of $28,000 to four communities. These induced damages are not an explicit cost of the project. No one has to actually pay this cost to implement the project. Nonetheless, an expected annual loss of $28,000 worth of resources are destroyed by the project.

How should the induced damages be incorporated into the economic analysis? Negative externalities such as induced flooding are economic costs and should be included among the NED project costs. It is a common practice to subtract induced damages from project benefits to avoid having costs of induced damages interfere with cost allocations in multiple purpose projects and cost-sharing percentages in general.

Negative externalities like induced flooding cause opportunity costs as real as any explicit cost of the project. Typically, in an economic analysis all costs are included on the cost side of the benefit-cost ledger. Table 6 shows that different handlings of the induced damages can result in different benefit-cost ratios without changing net benefits.[63] There is no effect on project feasibility and the current practice, though not a formal policy requirement, is favored when the existence of induced flood damages may influence cost-sharing in any way. Like many policies in practice, this one continues to evolve.

OTHER EXTERNALITIES

Virtually every water resource project will produce some externalities. The nature of the externalities will vary from project-to-project. For example, constructing a jetty to

TABLE 5: INDUCED FLOOD DAMAGES

Community	EAD Without	EAD With	Induced EAD
Midvale	25,000	27,000	2,000
Smallville	40,000	45,000	5,000
Metropolis	175,000	195,000	20,000
Gotham	5,000	6,000	1,000
TOTAL	245,000	273,000	28,000

TABLE 6: INDUCED DAMAGE EFFECT ON PROJECT ECONOMICS	
ITEM	**AMOUNT**
Annual Project Costs	$280,000
Annual Induced Damages	$28,000
Total Annual Costs	$308,000
Total Annual Benefits	$350,000
BCR w/o I.D.	1.25
BCR w/I.D.	1.14
BCR w/benefits offset	1.15
Net Benefits w/o I.D.	$70,000
Net Benefits w/I.D.	$42,000

stabilize a channel through an inlet may exacerbate erosion rates updrift or downdrift of the jetty. The costs associated with the increase in erosion rates are NED costs. They may be explicit costs if downdrift communities must incur additional expenses to combat the increased erosion rates; or they may be implicit costs if less beach area means more congested recreation use of the beach.

Deepening the channel in one port may result in a transfer of tonnage from other ports. Though policy precludes reliance on such transfers for the benefit cost analysis the transfers are nonetheless real and may be NED costs. May is the key word in this and many other examples of externalities. Many water resource project externalities are **regional economic development** (RED) effects rather than NED effects. The difference between RED and NED effects is discussed in some detail in *National Economic Development Procedures Manual- Overview Manual for Conducting National Economic Development Analysis.* In essence, an RED effect is a transfer of economic activity from one area to another with no net loss of activity or resources. NED effects are net losses of resources and economic activity.

A transfer of tonnage from one port to another may cost one port the loss of a number of jobs. Ordinarily, a loss of jobs would represent an opportunity cost to the nation. However, if the same number and kinds of jobs are created at the other port the nation has not lost any jobs. One area lost jobs, another area gained jobs and there is no net change. In this case, there would be a RED cost in one area and an RED benefit in the other area. There would be no NED cost or benefit.

When a project produces RED effects analyst frequently conclude there is no net change. This is often done more as a matter of analytical convenience than as a matter of fact. The real measure of NED costs when regional externalities are evident is in the net change in resources used to produce a given output.

For example, suppose a port processes 50,000 tons of aluminum annually. This is done at some total cost. If a project causes the processing of this tonnage to move to another port it will be done at some total cost. If there is no change in the total cost of processing the aluminum there is little incentive for the shipper to make the change. In the scheme of things the change may be minimal and not worth the resource required to estimate it, but that is not a priori true. Good economic analysis requires that any net change in resources used to produce a given level of output be quantified as an NED cost or benefit. Policy and politics may override the tenets of good economics in this case.

A reallocation of water supply at a reservoir may cause substantial externalities. A reallocation scheme that decreases recreation may impose costs on businesses that rely on recreation for their existence. Whether and how much of these costs are RED and NED must be addressed on a case-by-case basis.

SUMMARY AND LOOK FORWARD

Estimating NED costs is fraught with obstacles. Theoretical issues make it difficult to understand the nature of the value that should be estimated. Data requirements make some measurements difficult and others impossible. Local interests and new Corps planners who lack experience with economic analysis in general and NED costs specifically can find the entire business of two sets of costs and the peculiar language of economists and agency people a substantial obstacle to understanding. In this chapter some of the problems Corps analysts commonly deal with, were reviewed.

Differences between economic and financial costs cause analytical and communication problems more frequently than any other type of problem. These differences invariably stem from the need for different costs for differences purposes in the planning process, or the lack of perfectly competitive market conditions. The array of potential discrepancies has been reviewed and a number of common examples were given. In all of this it is important to bear in mind that NED costs, though generally synonymous with economic costs, can deviate from economic costs when a policy decision has been made that supersedes economic theory.

Interest during construction has been described as an equivalence adjustment of pre-base year costs. Interest during construction frequently confuses non-Federal partners who think of interest as a cost to be paid. It is not a financial cost. It is an NED cost that is included in the benefit-cost analysis to assure equivalence of all dollar values.

Planning and Real Estate Divisions in the Corps of Engineers frequently find themselves on opposite sides of the table when it comes to estimating property values. With different data and different needs for the data, the temptation to look on one or the other party's data as flawed is very strong in the absence of a clear understanding of the dual role of costs. The primary problems appear to be the lack of

understanding of one another's analytical responsibilities and the lack of an advance set of agreed upon principles that will guide the determination of the various real property values required for project formulation and implementation. The solution to these problems is communication.

Average annual costs are used to express a complex flow of money over time as a single value. Negative externalities are one class of costs that can be overlooked in the estimation of average annual NED costs if the project analyst is not attuned to looking for them.

The chapter that follows attempts to unite the content of the first five chapters in a single example. A cost estimate for a hypothetical project is used to relate the dual nature of costs in the Corps planning process through a number of sample cost adjustments.

Chapter 6: FROM PROJECT COSTS TO NED COSTS: AN ILLUSTRATED SUMMARY

CHAPTER OVERVIEW

The opening chapter of this manual stresses the fact that different cost data are required for formulating and selecting a project than are required for implementing a project. Though this manual focuses on national economic development costs, it is impossible to not pay substantial attention to the money costs of a project. In the second chapter, many different organizational elements that generate, use, or exchange cost information are described. With so many people using so much information, the need for careful communication of information needs among these groups is crucial. Communicating cost information is further complicated by a complex jargon reviewed in Chapter 3.

Two broad and overlapping types of communication problems arise for the Corps of Engineers. First, economists have difficulty communicating their notion of costs to laymen. Thus, economic issues may not be well understood by non-economists both in and outside the agency. Second, Corps personnel use jargon that is not generally understood by the public. To make matters worse, terminology may vary from one Corps district to another and from one element within a district to another. The result is that people outside the agency, principally non-Federal partners, may have great difficulty understanding the various cost concepts used.

NED costs are described in some detail in Chapter 4. Some recurring NED cost issues are discussed in Chapter 5. This chapter integrates many of the ideas presented earlier in the manual by translating the project costs into NED project costs in a hypothetical example.

This chapter is targeted at the new Corps analyst. The potential concerns addressed and the types of adjustments made are merely examples chosen from a much larger list of situations that could arise. This chapter may also provide a useful review for experienced analysts and a basic introduction of the complexity of the task confronting Corps analysts to those outside the agency.

A brief general description of a hypothetical implementation cost estimate follows. The next section suggests a general approach to the problem of translating project costs to NED project costs. In subsequent sections, the six steps of this general approach are applied.

PROJECT COSTS

The example that follows is fact-based but hypothetical.

THE PROJECT

Plainville is a town located on the banks of the Heck River in Fair County. It has a long history of flooding. A reconnaissance study completed several years ago determined that a combination of levees and floodwalls provided an economically viable solution to the town's flood problems.

The feasibility study is nearing completion and

TABLE 7: PROJECT COST ESTIMATE (October 1, 1992 Price Level)

Lands & Damages:	
Acquisitions	$605,371
Condemnation	$24,568
Appraisals	$107,004
Relocation Assistance	$45,866
Real Estate Receipts & Payments	$2,767,216
Subtotal	$3,550,025
Relocation:	
Railroad Modifications	$195,713
Highway Bridge Replacement	$2,002,070
Railroad Shutdown	$28,838
Utilities & Structures	$563,264
Subtotal	$2,789,885
Fish & Wildlife Facilities	
Wildlife Facilities & Sanctuaries	$98,004
Subtotal	$98,004
Levees & Floodwalls	
Mob, Demob & Preparation Work	$192,895
Care & Diversion of Water	$172,217
Levee Service and Ramps	$293,003
Levees	$5,864,858
Floodwalls	$602,225
Drainage	$2,162,744
Flood Forecast & Warning System	$51,626
Subtotal	$9,339,568
Cultural Resource Preservation	$108,001
Planning, Engineering & Design	$3,030,069
Construction Management	$850,048
TOTAL PROJECT COST	$19,765,600

the project economist has just been provided with the project cost data summarized in Table 7.[64] These costs include no adjustment for inflation.

PROJECT COST ESTIMATE

The cost estimate was prepared as a result of the efforts of several elements of the Corps district, as described in Chapter 2. Real estate division provided the estimated cost of lands and damages. The environmental division provided the estimated cost of fish and wildlife facilities and cultural resource preservation. Engineering division prepared estimates of the remaining cost items with input from its hydraulics and hydrology, foundations, design, and cost estimating branches. M-CACES software has been used to construct the cost estimate in far more detail than is shown in the summary table. Contracts branch will solicit bids and award contracts for project construction. Project management, finance and accounting and others will carefully monitor the expenditure of the Federal and non-Federal money during construction.

These costs are of interest to many different parties. The non-Federal partner will pay part of these costs. Opponents of the plan will make its $19.8 million cost a local issue. Local congressmen and senators must convince appropriate House and Senate committees to include the project and the Federal share of its costs in authorization and appropriation bills. The entire Congress must approve the project and the Federal share of project costs. The Office of Management and Budget will want to assure the project is compatible with the President's program. The construction industry will watch the progress of the project with an eye toward bidding on it.

Despite the considerable effort that has gone into its preparation and the numbers of people interested in it, this cost estimate is not necessarily to be used as is for formulating or evaluating alternative plans. A project cost estimate provides the cost information needed to implement the project. NED project cost is the cost estimate needed to formulate and evaluate alternative plans. The costs in Table 7 are not yet NED project costs.

EQUIVALENCE OF COSTS

All costs must be equivalent in price level and time. The costs in Table 7 reflect price levels as of October 1, 1992. This means the price of every item included in the detailed cost estimate was the price that prevailed for that item in the study area on October 1, 1992. There is no future inflation built into these costs. The fully-funded cost, which includes inflation, is not shown but amounts to $21.7 million. This includes a $1.9 million increase to account for price level rises to the midpoint of the construction contract.

To make project costs equivalent in time, a few time periods must be defined. The construction period is three years based on expected financing of the project, optimal scheduling and the ability to accomplish the work. Once project review is completed, the PCA executed, etc. it is anticipated that construction will begin in 1997 and be completed by the end of 1999. The base year or first year in which the project is functionally completed is the year 2000. The period of analysis extends 100 years from the base year through 2099. The project life is expected to

be in excess of 150 years with continued maintenance.

The project costs presented in Table 7 are not yet equivalent in time. They have not been expressed in terms of their value at a fixed point in time; specifically, these costs are not expressed in terms of their value in the base year. The construction costs are incurred over the three years before the base year. Expressing them in terms of their equivalent value as of the base year will require a pre-base year equivalence adjustment. The lack of time equivalence alone means these costs cannot be used as NED costs.

NED COST ANALYST'S RESPONSIBILITIES

What is the project economist to do with these costs? He cannot simply take these costs and use them as is. Neither is it his job to evaluate the work of others. The project economist must carefully examine this work and determine what parts of it can be directly incorporated into the NED analysis and what parts of it must be adjusted first.

There are two necessary tasks to ensure a successful translation of project costs to NED project costs. The first, communication, must be taken before the cost estimate is prepared; the other task, application, is taken during or after preparation of the cost estimate.

COMMUNICATION

The critical first task in the project economist's NED cost analysis is to communicate his information needs early, clearly, specifically, and often. The language of costs is very complex and there is tremendous potential for confusion. As illustrated in Chapter 3 and throughout this manual, economists, engineers, and local officials all have their own terms that, though they use them very precisely, may, at best, be poorly understood by others. The multitude of users of and uses for cost information increase the opportunities for miscommunication.

There are different terms that can mean the same thing. The same term might mean different things to different people. Often the same terms can mean different things to the same person depending on the context in which it is used.[65] It's easy for an analyst to think he's communicating when he may only be talking out loud.

It takes a conscious and concerted effort to assure that what you intend to convey to your listener is what is being understood. Do not rely solely on jargon to communicate. Discussion and clarification is needed. This discussion should, at a minimum, clearly identify how the cost data will be used. A clear understanding of the different uses to which information can be put and the different forms it must take can help to avoid the conflicts that arise when: 1) one group feels another is intruding upon its area of professional responsibility; or, 2) one group feels another is wrong. Both the party requesting information and the party providing it are well-advised to check and recheck with each other as the information is developed to assure the needed information is being provided.

Communication is not criticism. If it comes too late in the study process it may arrive wrapped like criticism, "That's not what

we asked for." Undertaken early, clearly, specifically and often, communication can help analysts avoid many of the problems that frequently arise in an NED cost analysis. Always at the heart of this need for communication is the dichotomous nature of costs.

APPLICATION

It is the economist's job to scrutinize costs developed for one purpose before using them for another. Scrutiny is not evaluation, however. It is not the economist's job to review or approve the work that has been done by others. It is the economist's job to determine whether costs prepared by others must be adjusted in any way before they can be used in the economic analysis. If planners communicate effectively throughout the study process the adjustments should be able to be made without controversy.

Figure 26 summarizes the basic steps an economist should follow to translate implementation costs into NED costs. Step one is to identify specific issues in the study that might cause financial costs of construction and OMRR&R to differ from the economic costs of resources. Chapter 3 presents some theoretical reasons why these costs might diverge. Examples can be found in Chapters 4 and 5.

The second step in this translation process is to identify specific areas where economic costs might differ from NED costs. Public policy has, over the years, superseded economic theory in a number of areas. Illustrations appear throughout Chapters 3, 4 and 5. For example, certain Uniform Relocation Assistance Act costs are not included among NED costs. Costs of betterments are likewise omitted.

Once the relevant issue areas have been identified, the next steps are to measure the differences. Step three is to quantify the differences between financial and economic costs. This should be done on an issue-by-issue basis. The fourth step is to quantify the differences between economic and NED costs in a similar fashion. In step five the analyst should clearly document relevant facts, the rationale for each adjustment, and the calculation of each adjustment. Finally, in step six, the results of this analysis should be summarized and displayed clearly and effectively. These six steps are followed in the example provided in the following section.

Step 1:	Identify potential divergences in financial and economic costs
Step 2:	Identify potential divergences in economic and NED costs
Step 3:	Quantify differences in financial and economic costs
Step 4:	Quantify differences in economic and NED costs
Step 5:	Document relevant facts, rationale and calculations
Step 6:	Display results of analysis

Figure 26: From Project Costs to NED Costs

PLAINVILLE EXAMPLE

The Plainville flood control project cost estimate has been completed. The money required to implement this project is estimated to be $19,765,600 at October, 1992 price levels. These are not NED project costs. It is the economist's job to make whatever adjustments are necessary to project costs to obtain an estimate of NED project costs.

IDENTIFY POTENTIAL DIVERGENCES IN ECONOMIC, FINANCIAL & NED COSTS

At the initiation of the study and periodically throughout the study process, the study team met to identify potential issues that might cause implementation costs to deviate from NED costs (steps one and two above). When such issues arose, team members were able to communicate their data requirements and data gathering abilities and limitations to one another. As a result of this communication a number of issues, summarized below under the same major account headings presented in the table, were identified.

Lands and Damages

a. Damage Surveys. (See "Use of Real Property Values in Water Resources", page 77). A flood damage survey was needed early in the study. It was decided that planning personnel would conduct the survey and would estimate the replacement cost less depreciation for each structure in the flood plain. Real estate personnel advised them on the selection of a software package to use for this estimation work; trained them in its usage; and, provided assistance in estimating the depreciation of structures.

It was understood that these estimates would include no land values and would be used solely for flood damage estimation purposes. They are expected to deviate from real estate's own estimates of the value of specific structures. This presents no problem in as much as the different data were to be generated for different purposes. Because these data were used for benefit estimation, no adjustments to the project cost estimates was required as a result of this issue.

b. Donated Lands. (See "Transactions with Economic Cost but No Financial Cost," page 68). Plainville's largest corporation owned some land adjacent to the river where the levee was to be built. As a goodwill gesture, and for the tax deduction, the firm indicated their desire to donate the land to Plainville to defray the local expense of the project.

The project economist made everyone aware of the fact that though there may be no money cost for this land there would indeed be an economic cost of using it. The economic cost of the land would be included in the benefit-cost analysis. The real estate branch was asked to conduct an appraisal to provide the estimate of this value.

Whether money changes hands or not, the non-Federal sponsor wants to receive maximum credit toward its share of project costs for supplying the land to the Federal government. In addition to the real estate appraisal, negotiations with the non-Federal sponsor would be needed to determine the value with which the non-Federal sponsor would be credited. The study team agreed,

that even if the value negotiated with the non-Federal sponsor (the financial cost) was higher than the economic cost estimated from the appraisal, the economic cost would still be used in the benefit-cost analysis.

c. Streambed. (See "Streambed" sidebar, page 68). Plainville announced their intention to donate the streambed needed for the project. The streambed was rumored to have value as a source of gravel and coal. An appraisal for this land would also be required. It was anticipated that the financial and economic value of the land would be different. It was agreed that appraisers would establish its financial value and economists would establish its economic value.

d. Relocations. (See "Relocation Costs," page 58). Construction of the levee and floodwall would require the acquisition of a number of houses. Most of these houses were of very poor quality. Because of the provisions of the Uniform Relocation Assistance Act, the costs of relocating some residents of Plainville were expected to exceed the value of the properties acquired. Though there is no divergence between economic and financial costs from a theoretical viewpoint, policy dictates that certain of the Uniform Relocation Assistance Act costs be excluded from both project costs and NED costs. Thus economic and NED costs differ. These costs would be omitted from the benefit-cost analysis and the project costs.

e. Short-Run Perturbations in the Land Market. (See "Long-Run/Short-Run Cost Considerations," page 27). The flood of record occurred during the conduct of the study. As a result the bottom dropped right out of the housing market. The publicity generated by the study coupled with the flood had effectively eliminated any buyers from the Plainville floodplain housing market severely depressing market values in the short-run. The study team felt that over a 100-year period of analysis the current market values would not persist. Prices were expected to return to normal over the next five to ten years.

Relocations

a. Advanced Replacement of Bridges. (See "Cost as the Basis for Benefits," page 40). One railroad bridge and one highway bridge constrict river flows and must be replaced as a result of the project. The railroad bridge is 40 years old. The highway bridge is more than 50 years old. Replacing these bridges now for the project alleviates the need to replace them later as a result of their advancing age and deteriorating condition.

There is no divergence between financial and economic costs. Some study team members felt project costs should be reduced to reflect the fact that most of these costs would have been incurred sooner or later anyway. Current Corps policy in practice is to include all the costs of bridge replacement among project and NED costs. Some of the cost associated with bridge construction can be used as a measure of the benefit that results from the advanced replacement of the bridges.

b. Betterments. (See "What Is and Is Not an NED Project Cost," page 46). The highway bridge across the Heck River is a narrow one lane bridge. It is being rebuilt as a two-lane bridge. Any costs of betterment are to be excluded from the benefit-cost analysis.

Fish and Wildlife Facilities

a. Fish and Wildlife Losses. (See "Fish and Wildlife Habitat Mitigation Costs," page 58). Construction of the levee will cause the loss of about 10 acres of duck and small mammal habitat along the riverbank. None of these losses were considered significant enough to mitigate. These are economic costs with no financial costs.

Levees and Floodwalls

a. Unemployed and Underemployed Resources. (See "Economic Cost Less Than Financial Cost," page 66). Fair County has chronic and persistently high unemployment. Approximately 60 percent of the $9.3 million levee and floodwall cost is labor. The economic costs of this labor will be significantly less than its financial cost. NED project costs include the full costs of labor as a matter of policy. Some of the labor costs can be used to estimate redevelopment benefits, effectively a cost offset. Thus, economic and financial costs will not diverge as a matter of policy.

b. Monopoly. (See "Monopoly and Taxes" sidebar, page 65). The flood forecast and warning system that is to be installed includes some special ice and temperature detection capability that is available from one supplier that owns a patent on the equipment. The system is about twice as expensive as the most comparable systems sold under competitive bidding conditions. The project economist believes most of the difference in price is monopoly rent, i.e., profit. The economic cost will differ from the financial cost under these conditions. As a matter of policy, full employment is assumed. This assumption implies that production of this equipment cannot be increased. So, the full price, rather than the marginal cost of producing one more unit, is used as the NED cost.

Potential Cost Issues Not in Project Cost Accounts

a. Interest During Construction. (See "Interest During Construction," page 69). Construction costs are incurred over the three year period preceding the base year. These pre-base year costs must be made equivalent to all other costs by compounding them. This adjustment to the economic costs is not reflected in the implementation costs.

b. Externalities. (See "Externalities," page 80). This project causes induced flooding at a small residential community downstream and over a few farms. In addition, a heavily used urban park must be closed down for one year to provide access to the construction site and to ensure public safety. These externalities reflect two economic costs that will not appear in the project costs.

QUANTIFYING, DOCUMENTING AND DISPLAYING COST ADJUSTMENTS

Table 8 summarizes the adjustments made for each of the issues raised in the preceding section. There are two reductions in costs totaling $115,000 and three increases in costs totaling $2,503,000 for a net increase

TABLE 8: NED COST ADJUSTMENTS (October 1, 1992 Price Level)	
Damage Survey	$0
Donated Lands	-$85,000
Streambed	-$30,000
Relocations	$0
Short-Run Perturbation in Land Markets	$0
Advanced Replacement of Bridges	$0
Betterments	$0
Fish & Wildlife Losses	$30,000
Unemployed & Underemployed Resources	$0
Monopoly	$0
Interest During Construction	$2,183,000
Externalities	$290,000

of $2,388,000. The detailed documentation for the adjustment rationale and calculation will typically be part of the project files. The project report should include sufficient documentation to explain the cost adjustments to the public, reviewers and other interested parties.

Damage Survey[66]

No adjustment to costs was necessary because these cost data were used exclusively for benefit computations.

Donated Lands

The Corps' appraisal of the donated land estimated its value at $725,000. The non-Federal partner, disagreeing with this appraisal, had a second appraisal done that valued the land at $900,000. In a series of negotiations, the non-Federal partner received a credit toward their share of project costs of $810,000. The study team believed this $810,000 financial cost exceeded the land's true economic costs. The project economist, together with the appraiser, settled on the Corps' original appraised value as the best estimate of the economic value of the donated land. Hence, project costs of $810,000 were reduced by the difference between the appraised and negotiated values or $85,000

($810,000 less $725,000). The NED cost of the donated land is $725,000.

Streambed

During the course of the study it was determined that the streambed provided by Plainville had always been streambed. Under both the without project and with project conditions the streambed was expected to remain a streambed. Upon closer investigation, it was learned that the streambed had no recoverable gravel or coal deposits. Hence, the economic value of the streambed was determined to be zero. The financial value of the streambed was $30,000. The NED cost of the streambed is $0, so NED project costs are decreased by $30,000 to reflect this determination.

Relocations

Costs above and beyond the value of the structures acquired that are incurred as a result of the provisions of the Uniform Relocation Act are not included in the project costs. As a matter of policy they are not included among NED costs either. No adjustment was necessary.

Short-Run Perturbations in Land Markets

There is strong evidence to suggest that recent sale prices are depressed well below long-run market values. Fair market value appraisals made by real estate personnel adjusted the comparable sales values to reflect these market vacillations. There was still considerable debate about whether the adjusted values of the acquired structures were as high as the long-run values would be. As a matter of policy in practice the financial costs of these properties were used as the NED costs because it was impossible to obtain more reliable estimates of the long-run values with the available data. No adjustment to the project costs was made.

Advanced Replacement of Bridges

All costs for replacing the two bridges are included in the project costs. They are identical for financial and economic costs. Advanced replacement of bridges benefits (a cost offset) are included among project benefits. No adjustment is necessary for NED costs.

Betterments

During the course of the study it was determined that modern engineering design standards would not allow construction of a bridge like the one that was being replaced. The entire cost of the new two lane bridge was considered to be a replacement in-kind, that provided little more than minimally acceptable design standards. As a result, the entire costs of bridge replacement are considered both financial and economic costs. No adjustment to NED costs is necessary.

Fish and Wildlife Losses

Project costs include no mitigation for the loss of the ten acres of habitat adjacent to the Heck River. Objective measures of the value of the lost habitat were not available. In order to provide some quantification of these costs a review of mitigation reports was undertaken. The cost of mitigating habitat losses in a

similar area was found in a 1991 report. Adjusting these mitigation costs for price level differences, a cost of $3,000 per acre was used for each of the ten lost acres. These costs are not included among project costs so NED costs are increased by $30,000.

Unemployed and Underemployed Resources

The P&G require the assumption of fully employed resources. Hence policy supersedes any evidence to the contrary. The single exception to this rule is unemployed and underemployed labor resources. However, NED costs are comprised of the full amount of the financial costs of the labor. Adjustments for unemployed and underemployed resources are made on the benefit side of the ledger as a matter of policy[67]. Once again, no adjustment to NED project costs is required.

Monopoly

New Corps economists or economists outside the agency might consider it appropriate, on the basis of economic theory, to make adjustments to monopoly costs in some situations. The P&G's assumption of fully employed resources has the effect of ensuring that resource values are best represented by the actual sale price. As a result, no adjustments to the flood forecast and warning cost are required to get NED costs.

Interest During Construction

Pre-base year costs must be expressed in equivalent dollars as of the base year. This calculation depends on the project's construction schedule, the interest rate, and the NED project costs (not the project costs, which are typically used as the basis for interest during construction calculations) that must be adjusted. In this case, the pre-base year adjustment is based on all the NED project costs that occur prior to the base year, including the external cost of closing the adjacent park (see next section). NED costs that occur after the base year, such as induced damages are not adjusted in this way. The pre-base year cost equivalence adjustment for this project totals $2,183,000[68]. This cost is not part of nor is it necessarily based upon project costs.

Externalities

The accumulated present worth of the increase in induced flood damages is $200,000. These costs accrue after the base year. Closing the urban park, prior to the base year, is expected to result in net losses of $90,000. Neither of these losses are reflected in the project costs. To include them in NED costs, project costs are increased by the sum of these two, or by $290,000.

Total Adjustments

Table 9 shows project costs, the necessary adjustments and the resulting NED project costs. NED project costs of $22,153,600 are used for the benefit-cost analysis. Average annual construction costs based on a 100-year period of analysis and a discount rate of 8.5 percent are $1,884,000. OMRR&R costs are estimated to be $78,000 annually, bringing total annual costs to $1,962,000. A table like Table 9 with text supporting the adjustments should be prepared for every NED cost analysis. The

table makes explicit the primary message of this manual, that there are different costs for different purposes.

SUMMARY

Is NED cost analysis confusing? Absolutely! The language is complex and it's not the only cost analysis involved in a planning study. Is NED cost analysis impossible? Clearly not.

Though difficult and unique NED cost issues will always arise, the keys to a good NED cost analysis are two-fold. First, always keep in mind the dual use of costs in a water resource planning study. NED project costs are used for the economic analyses that are such an essential part of plan formulation. Project costs, which
invariably differ from NED costs, are used to implement the project.

The second key to a good analysis is communication. If the rules for analysis are laid out well in advance of initiating the work there will be less chance of miscommunication. Communication among all study interests should begin early and be clear, specific and frequent. This communication must occur at several levels. It begins with the Corps. Study team members must communicate among themselves. There must be communication among all the Corps elements that will become involved in the formulation or implementation activities. Perhaps of greatest importance is the need to communicate effectively with the non-Federal partner and all local interests.

ENDNOTES

Endnotes

Chapter 1:

1. The Project Cost Agreement or PCA is new terminology to replace the former Local Cooperation Agreement (LCA).

2. Institute for Water Resources Report 91-R-11 entitled, *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*, October 1991 provides an introduction to the NED objective and principles of NED analysis in general.

Chapter 2:

3. EP 1105-2-10 entitled "Six Steps to a Civil Works Project," provides a concise summary of the civil works planning process that details these methods and expands on other aspects of this overview.

4. The matter of "perspective" is no small point and should not be overlooked. There are many perspectives that can be taken when considering the impacts of a project. If you buy a saxophone to teach yourself how to play, you consider only the cost of the instrument. Your neighbors, subjected to your endless and apparently fruitless practicing pay the cost of hours of disrupted leisure. The facts here are unassailable, you are playing a sax badly. The costs depend on the perspective you take. For you it was the dollar cost of the sax, for your neighbors it is the loss of peace and quiet. One cost is easily quantified in dollars, the other is not; yet both are clearly costs. In the case of water resources planning, the federal, state and local governments all take different perspectives. The perspective they take influences the way in which they see and identify costs.

5. Financial Analysis is discussed in Section XIV of ER 1105-2-100.

6. It is an oversimplification to say that costs alone are the basis for determining economic efficiency and cost-sharing. Benefits, costs and current policy are required to determine such issues.

Chapter 3:

7. This "thing" may be a good or a service. For simplicity we avoid consideration of bads like pollution and toxic wastes.

8. Price, in this sense, can be interpreted as a measure of a good's relative scarcity. Determined by the interaction of supply and demand, price reflects the relative balance between the desire for a good and its availability. Things with low prices are relatively less scarce than goods and services with high prices.

9. Cash should be broadly construed here to include all cash substitutes like checks, travellers checks, etc.

10. Financial costs are defined for cost allocation purposes in ER 1105-2-100 page 5-27 as ".. implementation outlays, transfer payments such as replacement housing assistance payments as specified in 42 U.S.C. 4623 and 4624, and the market value of contributions in kind, e.g., lands." They are alternatively defined on page 5-42 as "..any money outlays or accounting transactions or entries whether or not these payments are for resources."

11. For example, the first meaning, opportunity costs, might differ from the NED meaning in very subtle ways. The economic cost of alternative forms of transportation considered in evaluating navigation projects would, by the first definition, be the marginal cost of moving the commodity by that alternative means. The NED cost is the published rate, which probably is not the marginal cost. This is a difference, so it is not, strictly speaking, true that the two meanings of economic costs are identical. However, we feel the terms are compatible enough and the differences are so subtle that little is lost by considering the two meanings to effectively be synonyms.

12. Incremental cost has two related but different meanings within the Corps' program. First, it is used as defined in this section to refer to changes in the level of output. The second use, discussed later in the manual, refers to the cost of adding a different component to a plan, called a separable element. At an intuitive level the difference between the two can be thought of as the difference between various levels of the same output and various levels of different, but closely related, outputs.

13. The definition of marginal benefits is similar to that of marginal costs. Marginal benefits are the *change* in total benefits that result from a *change* in project output.

14. Marginal costs reflect the change in total costs. Mathematically, marginal costs reflect the first derivative of the total cost function with respect to the quantity of output.

15. Constant marginal costs may be observed over an extended range of output and are often assumed for the ease of exposition.

16. The relationship between average and marginal measures of the same variable, like costs, is an interesting one. As long as marginal costs lie below average costs, average costs will decline. When marginal costs lie above average costs, average costs will increase. The border line between declining and rising average costs would be reached at the bottom of the "U" where average costs are at a minimum. At this point marginal costs are neither above nor below average costs, so they must be equal.

17. The NED plan is that plan which maximizes net NED benefits.

18. As a historical footnote, Senate Document Number 97, 87th Congress, Second Session (1962), one of the spiritual precursors of the P&G used the term **project economic cost** to mean:

> "The value of all goods and services..used in constructing, operating, and maintaining a project..interest during construction, and all other identifiable expenses, losses, liabilities, and induced adverse effects..whether tangible or intangible and whether or not compensation is involved...Project economic costs are the sum of installation costs' operation, maintenance, and replacement costs; and induced costs.."

19. When used in this sense, implementation cost is broadly construed to represent all the costs of implementing a plan in cooperation with the non-Federal partner. Thus, when we talk about the costs of implementing a project it includes construction costs and OMRR&R costs. This distinguishes implementation costs in this context from its narrower reference to construction costs as included in the P&G.

20. M-CACES is pronounced "em-kay-cees".

21. Willingness to pay should not be confused with price. As long as we are willing to pay at least as much as the price of a good or service we purchase it. When price exceeds our willingness to pay we do not make the purchase. Additional discussion of willingness to pay can be found in the *Overview Manual for Conducting National Economic Development Analysis.*

22. The *Overview Manual for Conducting National Economic Development Analysis* contains a discussion of this measure of willingness to pay.

Chapter 4:

23. This is not strictly true. There is likely to be some net change in benefits and cost. For simplicity we assume no net difference in costs or benefits.

24. The concise definition of NED costs is found in paragraph 2.12.2(a) of the P&G. Paragraph 2.12.2(c) actually refers to private sector and public sector uses of a resource. This terminology is equivalent in meaning to the private and social costs discussed in the manual.

25. An expanded discussion of these principles can be found in the *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*.

26. It can be demonstrated that at each point on the demand curve marginal utility and price are equal. If we interpret marginal utility to be the marginal benefits of consumption, then each price on the demand curve represents the marginal benefit of a utility/benefit maximizing consumer. The supply curve is, of course, the firm's short-run marginal cost curve.

27. Some agencies have developed adjustment factors that are based on more or less sophisticated analytical techniques. The World Bank uses factors to convert observed currency exchange rates and labor costs to their shadow costs. For example, the true price of a nation's currency may be estimated by multiplying the official exchange rate by, say, 0.8.

28. Betterments come about in one of two basic ways. First, local interests may want something that is bigger (quantitative improvement) or better (qualitative improvement). Second, modern engineering design standards may result in an improvement. For example, it may no longer be acceptable practice to use materials, designs or dimensions previously used. Replacing an existing bridge with the new standard bridge may produce both quantitative and qualitative improvements.

29. A discussion of the compounding of costs is deferred until the discussion of interest during construction, in Chapter 6.

30. Both of these references can be found in paragraph 2.12.4(b) of the P&G.

31. Paragraph 2.1.2(a) of the P&G is the source of this term. Installation is used in place of the term construction to cover projects that are nonstructural in nature as well as those that require construction of a project.

32. Found in paragraph 1.4.12.

33. Paragraph 5-7.a. of EP 1165-2-1 *Digest of Water Resource Policies and Authorities*. The cited paragraph mistakenly implies the period of analysis and project life are identical terms.

34. Costs can be seen as a stream of expenditures over time, benefits as a stream of income.

35. This growth, when extended over a number of time periods is sometimes referred to as **compounding**. Compounding occurs when the amount of growth becomes part of the base at the end of a specified period. For

example, compounded interest means the interest earned on principal in one year becomes part of the principal on which interest will be earned in the next year.

36. The formulas presented here are for adjusting values that are one year apart. To compare two sums of money that are an arbitrary "n" years apart the formulas become:

$$FV = PV \times (1+r)^n$$
$$PV = FV/(1+r)^n$$

Where FV is future value, PV is present value, and r is the interest rate.

37. This is tricky. An adjustment is made to costs that occur prior to 1995 to make them equivalent in time to all other costs. That adjustment is more formally the calculation of interest during construction. For simplicity and to maintain the symmetry of the argument we can think of this as allowing costs to grow.

38. For example, suppose you have the money needed for the levee in the bank. The bank would charge you 10 percent interest on a loan and they pay you 5 percent interest on your account. The opportunity cost of the levee is 10 percent if you borrow the money. If you use your own funds it's a little trickier. Obviously you will lose at least 5 percent if you withdraw your money. But, if you could have lent the money on your own at the going rate, your opportunity cost will be 10 percent. Because savers can rarely lend directly to borrowers there is often a discrepancy in the perceived opportunity costs to savers and borrowers.

39. Paragraphs 2.1.3. and 2.12.4(b).

40. The P&G requirement that an NED plan maximizing net NED benefits be identified is mathematically equivalent to maximizing the net present value of NED benefits.

41. For example, flood control benefits accrue to a project with the random occurrence of floods. The value of these benefits is estimated by the expected annual value of flood damages.

42. Why are there interest charges? There are two ways to look at this. Suppose we had to take out a loan to cover the construction costs. In this case, we would clearly expect to have to pay interest for the loan. When the project is financed without the use of a loan we as society still incur an opportunity cost. Rather than spend, say, $100 million on this project, we could invest this money in some other way. Suppose we put the money in a certificate of deposit that would yield 8 percent interest. Then using the money for a project costs us the opportunity to earn this 8 percent return. Thus, we incur the explicit costs of construction plus the implicit cost of a foregone return.

43. The amortization or capital recovery factor is given by the following formula: Amortization = $(r(1+r)^n)/((1+r)^n-1)$, where r is the discount rate and n the number of years.

44. The amortization factor presented in the preceding footnote is mathematically equivalent to the sum of the **sinking fund factor** plus the interest rate. The sinking fund factor is used to determine the annuity that will grow over a given period of time to a predetermined value if each value grows at a compound rate. The sinking fund is defined as $(r)/((1+r)^n-1)$ and the interest rate is r.

45. It would appear that this term is used in place of **installation cost**, the term in vogue at the time of Senate Document 97. Installation cost was defined as follows:

> The value of goods and services necessary for the establishment of the project, including initial project construction: land, easements, rights-of-way, and water rights; capital outlays to relocate facilities or prevent damages; and all other expenditures for investigations and surveys, and designing, planning and constructing a project after its authorization.

The issue of which study costs were to be included among the economic project costs was handled here as a matter of policy.

46. Or at the time these costs are subsequently updated.

47. The P&G takes great pains in its language not to preclude the possibility that a recommended plan might not require construction. Nonstructural plans might require policy changes or new behaviors. Hence, the P&G speaks of installing measures. For convenience this manual will tend to speak of project construction. For clarity it should be understood that this terminology is intended to cover implementation of any and all project types.

48. Associated costs were defined in Senate Document 97 as follows:
> The value of goods and services over and above those included in project costs needed to make the immediate products or services of the project available for use or sale.

Chapter 5:

49. If not, we cannot assume there was no financial cost, however. As you will note from the above definition of financial costs it is sufficient that there be an accounting transaction or entry. A financial cost is incurred when the non-Federal partner is credited for lands provided for the project whether there has been an exchange of money or not.

50. Some exceptions have been discussed in previous sections. These include betterments and certain relocation assistance costs among other things.

51. The base year has been defined as the first year in which the project is operationally complete. This has most often been interpreted to mean that the project has been essentially completed to the point that the majority of the benefits it is expected to produce may begin to accrue.

52. Time zero ($t = 0$) is defined as the effective completion of the project or the beginning of the base year. Benefits or costs that are considered end of year values that occur at the end of the base year must be discounted. Thus, generally, base year values should be discounted.

53. It is not intuitively appealing to think of construction costs that have not yet been incurred as "past" costs. This is only true in a relative sense. If we take the base year to be the point in time at which all dollar values are compared, then values after this point are future and values before this point are past.

54. For a discussion of the role of property values in flood control benefit estimation see *National Economic Development Procedures Manual - Urban Flood Damage Volumes I and II.*

55. See ER 1105-2-100, paragraph 6-167.

56. In a typical flood event some percent of the structure and its contents are lost due to flooding. For example, five feet of water on the first floor of a particular type of building may result in a 10 percent loss of the value of the structure. This means that the in-kind value of the resources lost in the flood are worth approximately 10 percent of the structure's value. Ten percent of $60,000 is $6,000 worth of materials and labor to restore the house to its former utility. If we used the cost-sharing estimate, damages would be only $5,000, one-sixth lower than the actual damages.

57. In theory, all three methods would result in the same value. In reality, however, the assumptions that assure the same answer from each method are not obtained. Goods sell at prices that vary from the costs of producing them all the time. There would be no profit or loss if they did not. Likewise, people may underestimate or overestimate the uncertain future value of an asset. The stock market is based on this simple fact.

58. The value of a unique resource to many individuals is a subjective matter, with each placing a different value on the resource. To confound things further, future generations may place even different values on the resource. When such considerations are real and significant, measurement of the appropriate data becomes practically impossible.

59. Historic or culturally significant structures may derive some of their significance from the construction method. In such cases, reproducing the structure using modern construction materials and techniques would fail to match the utility of the structure because it would not impart the same information about historic construction materials and techniques.

60. Capital recovery is the process of regaining the financial capital plus interest invested in a project. The factor used to compute the amount of money required at the end of each year to recover this investment is the capital recovery factor. The capital recovery factor is:

(1) $CRF = [r(1+r)^N-1]/[(1+r)^N-1]$

where r is the discount rate and N the length of the planning horizon or the recovery period.

61. Externalities may also be beneficial; bestowing unintentional benefits on parties who do not have to pay for the benefits they receive.

62. It is equally important, though not the focus of this manual, that positive externalities be considered as well. In some cases the marginal private benefits and marginal social benefits will differ. To keep attention more sharply focussed on cost issues we have avoided discussion of beneficial externalities.

63. The BCR without induced damages included among costs is $350,000/$280,000. With induced damages included, the BCR is $350,000/$308,000. If induced damages are used to affect benefits the BCR is $322,000/$280,000.

Chapter 6:

64. The cost estimate line items and their magnitudes are all based on actual Corps projects. The adjustments to project costs discussed later in this chapter are based on situations that have arisen in a variety of Corps projects.

65. For example, first cost and construction costs are examples of the first case; both mean the same thing. To local interests and project managers, fully-funded cost means project costs adjusted to include inflation through the construction period. Programs personnel think of fully-funded cost as implying all the necessary funds have been appropriated and are available to be spent. An example of the third situation is incremental cost. Normally it is used like marginal cost. In context, however, it may be understood to mean the cost of a separable element. Other examples can be found throughout this manual.

66. A damage survey is an inventory of properties located in the floodplain at risk from flooding. Data collected in a survey varies from survey to survey. However, estimation of the value of the structures at risk is a common element of most surveys.

67. For a more complete discussion of this topic see the *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*.

68. This adjustment was obtained by estimating monthly expenditures for each of the 36 months of construction and the timing of all pre-base year costs not included among project costs. Each of these 36 monthly expenses was adjusted individually and summed.

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U.S. Water Resources Council, "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies." Washington, DC: US GPO, March 10, 1983.

Appendix 1: A BRIEF HISTORY OF THE NED PERSPECTIVE

Appendix 1: A BRIEF HISTORY OF THE NED PERSPECTIVE

The Nation's economic development is not a new concern of water resource development. The first public works project undertaken by the Federal government was the construction of a lighthouse at Cape Henry, Virginia, authorized on August 7, 1789 in recognition of the fact that coastal and foreign shipping was the lifeblood of the nation's economy. In 1808, Treasury Secretary Albert Gallatin presented a foresighted report on the need for future development of a system of roads and inland water routes that would unite the states and provide access to the nation's interior. The economic development of the region west of the Appalachian mountains was, at the time, one of the principal motivations for the report.

The history of the Corps, and indeed the Nation, is replete with examples of legislation and committee reports providing for the economic development of our Nation. Interest in the nation's economic development is as old as the Nation itself. The requirement to evaluate the economic effects of a project dates back over 50 years to the Flood Control Act of 1936. What are relatively new are the requirement to explicitly evaluate and quantify these effects according to a specific set of standards and procedures and the emphasis this requirement receives.

Early enabling legislation of the water resource development agencies consistently required that reports demonstrate the economic value of the projects. Widespread use of benefit-cost analysis as a test of a project's economic worth is generally considered to have grown out of section I of the Flood Control Act of 1936.

Benefit-cost analysis did not become the principal basis for agency project recommendations until the post-World War II period. The directive to estimate the benefits and costs of flood control projects was soon extended to all water resource development purposes. In the ensuing years standard methods of evaluating benefits and costs evolved slowly.

In December, 1952 the Bureau of the Budget issued Circular A-47 to water resource agency heads to inform them of the standards it intended to use to accept or reject agency evaluations of water projects. Each water resource agency adopted different and often inconsistent criteria for estimating benefits and costs.

In May 1958, "Proposed Practices for Economic Analysis of River Basin Projects", which was to become known by the color of its cover as the "Green Book", was issued. The Green Book addressed regional effects, formulation issues, and benefit and cost evaluation, among other topics. The genesis of much of the Corps' current economic guidance can be found in the pages of the Green Book.

In May, 1962 the Water Resources Council issued its "Policies, Standards and

Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources". Better known as Senate Document 97, this document replaced the superseded Budget Bureau Circular A-47. SD 97 provides that the basic objective of plan formulation is to provide for the best use of resources. It appears to provide the first formal reference to "national economic development."

The Water Resources Planning Act of 1965 (P.L. 89-80) required the newly created Water Resources Council (WRC) to establish principles, standards and procedures for Federal water resources planning. In September, 1973 the WRC established the "Principles and Standards for Planning Water and Related Land Resources" (P&S). For the first time, National Economic Development (NED) is mentioned explicitly as one of two overall purposes of water resource planning, the other being environmental quality.

The P&S were amended slightly in August, 1974 and WRC, in response to the President's June 1978 directive, developed a single set of procedures to ensure benefits and costs are estimated using the best current techniques. "Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C)" were published in December, 1979. These Procedures are the step-by-step procedures for evaluating benefits for M&I water supply, urban flood damage, NED costs, etc., that are well-known to Corps planners. This was the first systematic description of the NED benefit and cost evaluation procedures formally presented.

In September, 1982 the P&S were repealed and replaced in March, 1983 by the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" (P&G). P&G firmly established NED as the Federal objective saying, in part:

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

Thus, it is that Federal water resources planning takes a distinctly national view of all economic effects.

Appendix 2: SUGGESTIONS FOR FURTHER READING

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PLAN FORMULATION COSTS

The Corps of Engineers' plan formulation process is unique to the agency. The academic and popular literature do not explicitly address plan formulation, benefit-cost analysis or NED costs. There are a number of books, however, that address the economic concepts inherent in these topics. A few of these and some Corps guidance are annotated below.

Baumol, William J. and Alan S. Blinder. *Economics Principles and Policy*. San Diego: Harcourt Brace Jovanovich, 1991, 5th ed. One of many economics principles texts that provides a good introduction to many of the concepts presented in this manual. The text provides a good introduction to opportunity cost, marginal analysis and the typical cost relationships. This book should be accessible to college-educated readers.

James, L. Douglas and Robert R. Lee. Economics of Water Resources Planning. New York, NY: McGraw-Hill, 1971. Somewhat dated, but still the most comprehensive treatment of water resource economics. Many of the topics of this manual are addressed throughout the text. It has a particularly good chapter on cost allocation.

Seo, K. K. Managerial Economics. Homewood, IL: Irwin, 1991. One of many managerial economics textbooks that gives a more detailed and intuitive discussion of the economic aspects of costs than is usually found in a principles texts. This text provides a more developed discussion of production, cost analysis, and empirical cost estimation. The presentation of costs in a managerial economics texts is generally more accessible to the non-economist than the presentation found in an intermediate or advanced theory text.

U.S. Army Corps of Engineers. "Guidance for Conducting Civil Works Planning Studies". ER 1105-2-100. Washington, DC: U.S. Army Corps of Engineers, 28 December 1990. Better known as the Planning Guidance Notebook, this ER is the single best collection of planning policy guidance available. It is also the best collection of economic analysis guidance. Many of the terms used in this manual are defined or discussed in this reference. This reference is official guidance and is written in a very formal style.

U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources, National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis. IWR Report 91-R-11. Fort Belvoir, VA: Institute for Water Resources, October 1991. The overview manual is the best starting point for anyone who is trying to become familiar with the role of economics in the Corps' plan formulation process. It presents the general concepts that underlie the NED concept. Although it focuses primarily on NED benefits there is a chapter on NED costs. This manual has been written primarily for non-Federal interests and planners who are not economists.

U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources, National Economic Development Procedures Manual Series. IWR Reports. Fort Belvoir, VA: Institute for Water Resources, various dates. The Institute for Water Resources has prepared a series of manuals that provide additional details on the economic analysis of a large and growing number of topics. These include flood control (two volumes), deep draft navigation, inland navigation, coastal storm damage and erosion, and recreation.

U.S. Water Resources Council, "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies." Washington, DC: US GPO, March 10, 1983. This document, better known as "the P&G", is the bible for Corps planners. It should be consulted by anyone interested in the details of the Corps planning process. The P&G are valuable in that it is the seminal document. For that same reason it is not rich in examples.

PROJECT IMPLEMENTATION COSTS

Agency literature is the only source of information about the language and uses of costs in the implementation of a project. All of these documents have been developed for the internal use of the agency and can be difficult for those outside the agency to read.

U.S. Army Corps of Engineers. Civil Works Construction Cost Index System (CWCCIS). EM 1110-2-1304. Washington, DC: U.S. Army Corps of Engineers, 12 October 1988. U.S. Army Corps of Engineers. "Civil Works Cost Engineering." Draft ER 1110-8-1(FR). Washington, DC: U.S. Army Corps of Engineers, 7 December 1992. This ER focusses on effective development, management and control of costs for all phases of planning, design, and construction. The ER contains a number of general definitions of terms discussed in this document. It is the single best source of information about the concept of cost engineering. Though the referenced version is in draft form the final version will contain a comprehensive list of abbreviations and acronyms used in the discussion of costs within the agency. It also contains a valuable list of policy documents related to costs.

U.S. Army Corps of Engineers. Digest of Water Resources Policies and Authorities. EP 1165-2-1. Washington, D.C., 15 February 1989. The digest is one of the best general reference documents for the Corps' program available. It provides an excellent overview of the Corps' programs, policies, authorities, and activities available.

U.S. Army Corps of Engineers. "Local Cooperation Agreements for New Start Construction Projects". ER 1165-2-131. Washington, DC: U.S. Army Corps of Engineers, 15 April 1989. This ER will soon be replaced by a newer version. It and its successor are of great interest to the non-Federal partner. It contains the cost language that is of obvious interest to locals. Appendices F and G provide useful information about cost-sharing.

U.S. Army Corps of Engineers. "Real Estate Roles and Responsibilities for Civil Works: Local Cooperation and Full Federal Projects". Draft Chapter 12 of ER 405-1-12. Washington, DC: U.S. Army Corps of

Engineers, 24 August 1992. Many of the terms commonly used in real estate studies

are defined and discussed in this ER. Appendices provide helpful references and examples.

U.S. Army Corps of Engineers, "Project Management". ER 5-7-1(FR). Washington, DC: U.S. Army Corps of Engineers, 30 September 1992. This ER provides good definitions of many of the cost concepts that are used in project implementation.

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1. The Project Cost Agreement or PCA is new terminology to replace the former Local Cooperation Agreement (LCA).

2. Institute for Water Resources Report 91-R-11 entitled, *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*, October 1991 provides an introduction to the NED objective and principles of NED analysis in general.

3. EP 1105-2-10 entitled "Six Steps to a Civil Works Project," provides a concise summary of the civil works planning process that details these methods and expands on other aspects of this overview.

4. The matter of "perspective" is no small point and should not be overlooked. There are many perspectives that can be taken when considering the impacts of a project. If you buy a saxophone to teach yourself how to play, you consider only the cost of the instrument. Your neighbors, subjected to your endless and apparently fruitless practicing pay the cost of hours of disrupted leisure. The facts here are unassailable, you are playing a sax badly. The costs depend on the perspective you take. For you it was the dollar cost of the sax, for your neighbors it is the loss of peace and quiet. One cost is easily quantified in dollars, the other is not; yet both are clearly costs. In the case of water resources planning, the federal, state and local governments all take different perspectives. The perspective they take influences the way in which they see and identify costs.

5. Financial Analysis is discussed in Section XIV of ER 1105-2-100.

6. It is an oversimplification to say that costs alone are the basis for determining economic efficiency and cost-sharing. Benefits, costs and current policy are required to determine such issues.

7. This "thing" may be a good or a service. For simplicity we avoid consideration of bads like pollution and toxic wastes.

8. Price, in this sense, can be interpreted as a measure of a good's relative scarcity. Determined by the interaction of supply and demand, price reflects the relative balance between the desire for a good and its availability. Things with low prices are relatively less scarce than goods and services with high prices.

9. Cash should be broadly construed here to include all cash substitutes like checks, travellers checks, etc.

10. Financial costs are defined for cost allocation purposes in ER 1105-2-100 page 5-27 as ".. implementation outlays, transfer payments such as replacement housing assistance payments as specified in 42 U.S.C. 4623 and 4624, and the market value of contributions in kind, e.g., lands." They are alternatively defined on page 5-42 as "..any money outlays or accounting transactions or entries whether or not these payments are for resources."

11. For example, the first meaning, opportunity costs, might differ from the NED meaning in very subtle ways. The economic cost of alternative forms of transportation considered in evaluating navigation projects would, by the first definition, be the marginal cost of moving the commodity by that alternative means. The NED cost is the published rate, which probably is not the marginal cost. This is a difference, so it is not, strictly speaking, true that the two meanings of economic costs are identical. However, we feel the terms are compatible enough and the differences are so subtle that little is lost by considering the two meanings to effectively be synonyms.

12. Incremental cost has two related but different meanings within the Corps' program. First, it is used as defined in this section to refer to changes in the level of output. The second use, discussed later in the manual, refers to the cost of adding a different component to a plan, called a separable element. At an intuitive level the difference between the two can be thought of as the difference between various levels of the same output and various levels of different, but closely related, outputs.

13. The definition of marginal benefits is similar to that of marginal costs. Marginal benefits are the *change* in total benefits that result from a *change* in project output.

14. Marginal costs reflect the change in total costs. Mathematically, marginal costs reflect the first derivative of the total cost function with respect to the quantity of output.

15. Constant marginal costs may be observed over an extended range of output and are often assumed for the ease of exposition.

16. The relationship between average and marginal measures of the same variable, like costs, is an interesting one. As long as marginal costs lie below average costs, average costs will decline. When marginal costs lie above average costs, average costs will increase. The border line between declining and rising average costs would be reached at the bottom of the "U" where average costs are at a minimum. At this point marginal costs are neither above nor below average costs, so they must be equal.

17. The NED plan is that plan which maximizes net NED benefits.

18. As a historical footnote, Senate Document Number 97, 87th Congress, Second Session (1962), one of the spiritual precursors of the P&G used the term **project economic cost** to mean:

> "The value of all goods and services..used in constructing, operating, and maintaining a project..interest during construction, and all other identifiable expenses, losses, liabilities, and induced adverse effects..whether tangible or intangible and whether or not compensation is involved...Project economic costs are the sum of installation costs' operation, maintenance, and replacement costs; and induced costs.."

19. When used in this sense, implementation cost is broadly construed to represent all the costs of implementing a plan in cooperation with the non-Federal partner. Thus, when we talk about the costs of implementing a project it includes construction costs and OMRR&R costs. This distinguishes implementation costs in this context from its narrower reference to construction costs as included in the P&G.

20. M-CACES is pronounced "em-kay-cees".

21. Willingness to pay should not be confused with price. As long as we are willing to pay at least as much as the price of a good or service we purchase it. When price exceeds our willingness to pay we do not make the purchase. Additional discussion of willingness to pay can be found in the *Overview Manual for Conducting National Economic Development Analysis.*

22. The *Overview Manual for Conducting National Economic Development Analysis* contains a discussion of this measure of willingness to pay.

23. This is not strictly true. There is likely to be some net change in benefits and cost. For simplicity we assume no net difference in costs or benefits.

24. The concise definition of NED costs is found in paragraph 2.12.2(a) of the P&G. Paragraph 2.12.2(c) actually refers to private sector and public sector uses of a resource. This terminology is equivalent in meaning to the private and social costs discussed in the manual.

25. An expanded discussion of these principles can be found in the *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*.

26. It can be demonstrated that at each point on the demand curve marginal utility and price are equal. If we interpret marginal utility to be the marginal benefits of consumption, then each price on the demand curve represents the marginal benefit of a utility/benefit maximizing consumer. The supply curve is, of course, the firm's short-run marginal cost curve.

27. Some agencies have developed adjustment factors that are based on more or less sophisticated analytical techniques. The World Bank uses factors to convert observed currency exchange rates and labor costs to their shadow costs. For example, the true price of a nation's currency may be estimated by multiplying the official exchange rate by, say, 0.8.

28. Betterments come about in one of two basic ways. First, local interests may want something that is bigger (quantitative improvement) or better (qualitative improvement). Second, modern engineering design standards may result in an improvement. For example, it may no longer be acceptable practice to use materials, designs or dimensions previously used. Replacing an existing bridge with the new standard bridge may produce both quantitative and qualitative improvements.

29. A discussion of the compounding of costs is deferred until the discussion of interest during construction, in Chapter 6.

30. Both of these references can be found in paragraph 2.12.4(b) of the P&G.

31. Paragraph 2.1.2(a) of the P&G is the source of this term. Installation is used in place of the term construction to cover projects that are nonstructural in nature as well as those that require construction of a project.

32. Found in paragraph 1.4.12.

33. Paragraph 5-7.a. of EP 1165-2-1 *Digest of Water Resource Policies and Authorities*. The cited paragraph mistakenly implies the period of analysis and project life are identical terms.

34. Costs can be seen as a stream of expenditures over time, benefits as a stream of income.

35. This growth, when extended over a number of time periods is sometimes referred to as **compounding**. Compounding occurs when the amount of growth becomes part of the base at the end of a specified period. For example, compounded interest means the interest earned on principal in one year becomes part of the principal on which interest will be earned in the next year.

36. The formulas presented here are for adjusting values that are one year apart. To compare two sums of money that are an arbitrary "n" years apart the formulas become:

$$FV = PV \times (1+r)^n$$
$$PV = FV/(1+r)^n$$

Where FV is future value, PV is present value, and r is the interest rate.

37. This is tricky. An adjustment is made to costs that occur prior to 1995 to make them equivalent in time to all other costs. That adjustment is more formally the calculation of interest during construction. For simplicity and to maintain the symmetry of the argument we can think of this as allowing costs to grow.

38. For example, suppose you have the money needed for the levee in the bank. The bank would charge you 10 percent interest on a loan and they pay you 5 percent interest on your account. The opportunity cost of the levee is 10 percent if you borrow the money. If you use your own funds it's a little trickier. Obviously you will lose at least 5 percent if you withdraw your money. But, if you could have lent the money on your own at the going rate, your opportunity cost will be 10 percent. Because savers can rarely lend directly to borrowers there is often a discrepancy in the perceived opportunity costs to savers and borrowers.

39. Paragraphs 2.1.3. and 2.12.4(b).

40. The P&G requirement that an NED plan maximizing net NED benefits be identified is mathematically equivalent to maximizing the net present value of NED benefits.

41. For example, flood control benefits accrue to a project with the random occurrence of floods. The value of these benefits is estimated by the expected annual value of flood damages.

42. Why are there interest charges? There are two ways to look at this. Suppose we had to take out a loan to cover the construction costs. In this case, we would clearly expect to have to pay interest for the loan. When the project is financed without the use of a loan we as society still incur an opportunity cost. Rather than spend, say, $100 million on this project, we could invest this money in some other way. Suppose we put the money in a certificate of deposit that would yield 8 percent interest. Then using the money for a project costs us the opportunity to earn this 8 percent return. Thus, we incur the explicit costs of construction plus the implicit cost of a foregone return.

43. The amortization or capital recovery factor is given by the following formula: Amortization = $(r(1+r)^n)/((1+r)^n-1)$, where r is the discount rate and n the number of years.

44. The amortization factor presented in the preceding footnote is mathematically equivalent to the sum of the **sinking fund factor** plus the interest rate. The sinking fund factor is used to determine the annuity that will grow over a given period of time to a predetermined value if each value grows at a compound rate. The sinking fund is defined as $(r)/((1+r)^n-1)$ and the interest rate is r.

45. It would appear that this term is used in place of **installation cost**, the term in vogue at the time of Senate Document 97. Installation cost was defined as follows:

> The value of goods and services necessary for the establishment of the project, including initial project construction: land, easements, rights-of-way, and water rights; capital

> outlays to relocate facilities or prevent damages; and all other expenditures for investigations and surveys, and designing, planning and constructing a project after its authorization.

The issue of which study costs were to be included among the economic project costs was handled here as a matter of policy.

46. Or at the time these costs are subsequently updated.

47. The P&G takes great pains in its language not to preclude the possibility that a recommended plan might not require construction. Nonstructural plans might require policy changes or new behaviors. Hence, the P&G speaks of installing measures. For convenience this manual will tend to speak of project construction. For clarity it should be understood that this terminology is intended to cover implementation of any and all project types.

48. Associated costs were defined in Senate Document 97 as follows:

> The value of goods and services over and above those included in project costs needed to make the immediate products or services of the project available for use or sale.

49. If not, we cannot assume there was no financial cost, however. As you will note from the above definition of financial costs it is sufficient that there be an accounting transaction or entry. A financial cost is incurred when the non-Federal partner is credited for lands provided for the project whether there has been an exchange of money or not.

50. Some exceptions have been discussed in previous sections. These include betterments and certain relocation assistance costs among other things.

51. The base year has been defined as the first year in which the project is operationally complete. This has most often been interpreted to mean that the project has been essentially completed to the point that the majority of the benefits it is expected to produce may begin to accrue.

52. Time zero (t = 0) is defined as the effective completion of the project or the beginning of the base year. Benefits or costs that are considered end of year values that occur at the end of the base year must be discounted. Thus, generally, base year values should be discounted.

53. It is not intuitively appealing to think of construction costs that have not yet been incurred as "past" costs. This is only true in a relative sense. If we take the base year to be the point in time at which all dollar values are compared, then values after this point are future and values before this point are past.

54. For a discussion of the role of property values in flood control benefit estimation see *National Economic Development Procedures Manual - Urban Flood Damage Volumes I and II.*

55. See ER 1105-2-100, paragraph 6-167.

56. In a typical flood event some percent of the structure and its contents are lost due to flooding. For example, five feet of water on the first floor of a particular type of building may result in a 10 percent loss of the value of the structure. This means that the in-kind value of the resources lost in the flood are worth approximately 10 percent of the structure's value. Ten percent of $60,000 is $6,000 worth of materials and labor to restore the house to its former utility. If we used the cost-sharing estimate, damages would be only $5,000, one-sixth lower than the actual damages.

57. In theory, all three methods would result in the same value. In reality, however, the assumptions that assure the same answer from each method are not obtained. Goods sell at prices that vary from the costs of producing them all the time. There would be no profit or loss if they did not. Likewise, people may underestimate or overestimate the uncertain future value of an asset. The stock market is based on this simple fact.

58. The value of a unique resource to many individuals is a subjective matter, with each placing a different value on the resource. To confound things further, future generations may place even different values on the resource. When such considerations are real and significant, measurement of the appropriate data becomes practically impossible.

59. Historic or culturally significant structures may derive some of their significance from the construction method. In such cases, reproducing the structure using modern construction materials and techniques would fail to match the utility of the structure because it would not impart the same information about historic construction materials and techniques.

60. Capital recovery is the process of regaining the financial capital plus interest invested in a project. The factor used to compute the amount of money required at the end of each year to recover this investment is the capital recovery factor. The capital recovery factor is:

(1) $CRF = [r(1+r)^N-1]/[(1+r)^N-1]$

where r is the discount rate and N the length of the planning horizon or the recovery period.

61. Externalities may also be beneficial; bestowing unintentional benefits on parties who do not have to pay for the benefits they receive.

62. It is equally important, though not the focus of this manual, that positive externalities be considered as well. In some cases the marginal private benefits and marginal social benefits will differ. To keep attention more sharply focussed on cost issues we have avoided discussion of beneficial externalities.

63. The BCR without induced damages included among costs is $350,000/$280,000. With induced damages included, the BCR is $350,000/$308,000. If induced damages are used to affect benefits the BCR is $322,000/$280,000.

64. The cost estimate line items and their magnitudes are all based on actual Corps projects. The adjustments to project costs discussed later in this chapter are based on situations that have arisen in a variety of Corps projects.

65. For example, first cost and construction costs are examples of the first case; both mean the same thing. To local interests and project managers, fully-funded cost means project costs adjusted to include inflation through the construction period. Programs personnel think of fully-funded cost as implying all the necessary funds have been

appropriated and are available to be spent. An example of the third situation is incremental cost. Normally it is used like marginal cost. In context, however, it may be understood to mean the cost of a separable element. Other examples can be found throughout this manual.

66. A damage survey is an inventory of properties located in the floodplain at risk from flooding. Data collected in a survey varies from survey to survey. However, estimation of the value of the structures at risk is a common element of most surveys.

67. For a more complete discussion of this topic see the *National Economic Development Procedures Manual - Overview Manual for Conducting National Economic Development Analysis*.

68. This adjustment was obtained by estimating monthly expenditures for each of the 36 months of construction and the timing of all pre-base year costs not included among project costs. Each of these 36 monthly expenses was adjusted individually and summed.